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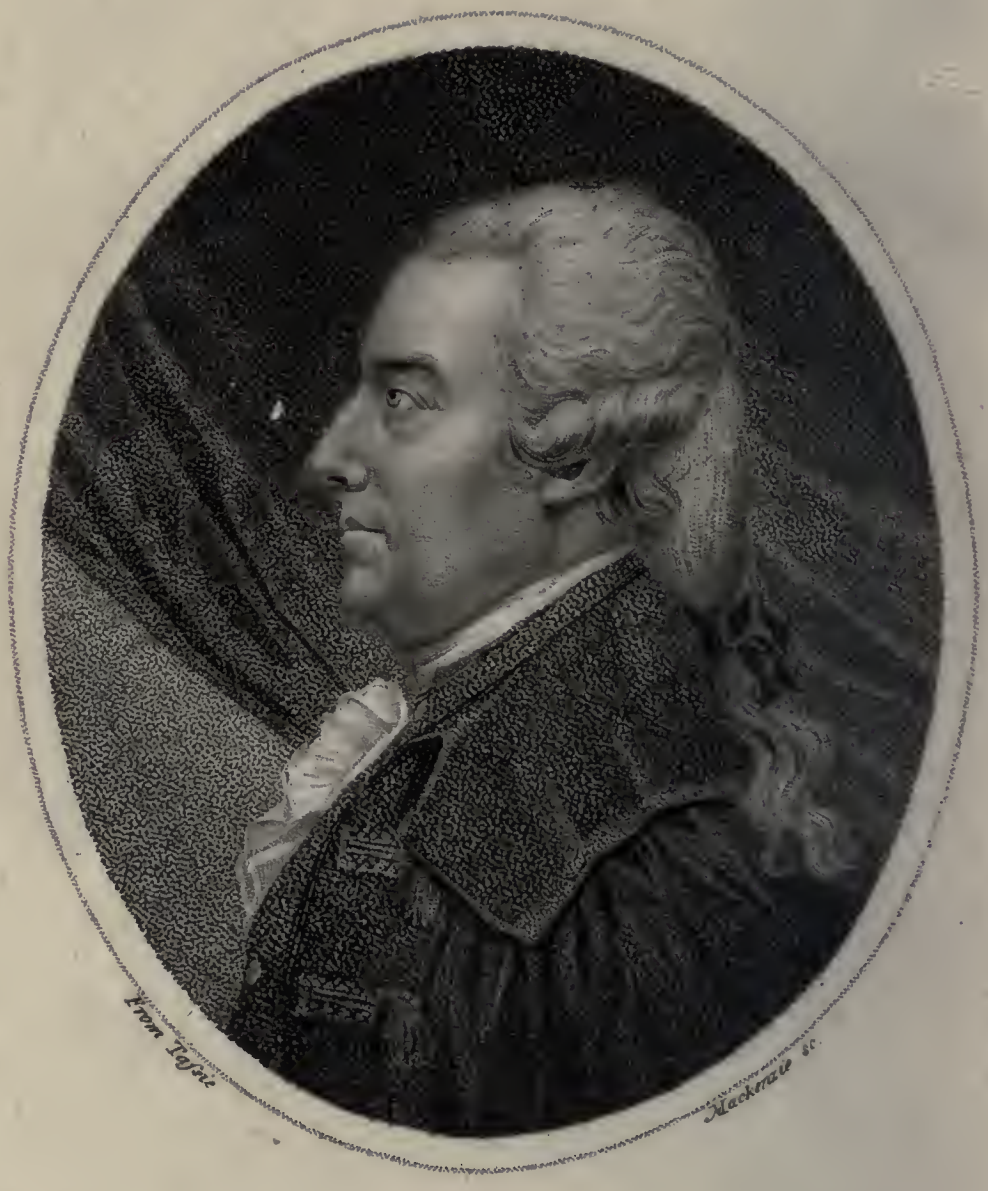

D.R JOHN ROBISON, *PR. of NAT. PHIL.* EDINBURGH

THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY, ETC. ETC.

"Nec aranearum ſane textus ideo melior, quia ex ſe fila gignunt. Nec noſter vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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THE PHILOSOPHICAL MAGAZINE.

I. *Letter from* C. HUMBOLDT *to* C. FOURCROY, *Member of the French National Inſtitute.*

Cumana, October 16, 1800.

THE capture of the iſland of Curacao, by the Engliſh and the Americans, having obliged the agent of the republic, C. Breſſot, and general Jeannet to re-embark their troops, in order to return to Guadaloupe, they have put into this port for want of proviſions; and though they intend to remain only twenty-four hours, I have endeavoured to collect for you ſome objects worthy of your attention, and which I hope will reach you in ſafety. You are well enough acquainted with the nature of my travels, and the difficulty and expenſe attending conveyance in the centre of a vaſt continent, to know that my object is rather to collect ideas than things. A ſociety of naturaliſts ſent out by government, accompanied with painters, collectors, packers, &c., might be able to embrace all the detail of the deſcriptive part of natural hiſtory, and, no doubt, would do ſo; but a private perſon, of a very moderate fortune, who undertakes a voyage round the world, ought to confine himſelf to objects more intereſting. To ſtudy the formation of the globe, and the ſtrata which compoſe it; to analyſe the atmoſphere; to meaſure, with the moſt accurate inſtruments, its elaſticity, its temperature, its humidity, its electric and magnetic charge; to obſerve the influence of climate on the animal and vegetable œconomy; to compare, on a grand ſcale, the chemiſtry and phyſiology of organized beings;—ſuch is the labour which I have propoſed. But, without loſing ſight of this principal object of my voyage, you may readily conceive that, with much zeal and a little activity, two men, who traverſe an unknown continent, may at the ſame time collect a great many things, and make a great many obſervations.

June 1801.

During the ſixteen months we have been traverſing the vaſt territory ſituated between the coaſt, the Orenoquo, Rio-Nigro, and the river of the Amazons, C. Bonpland has dried, with duplicates, more than ſix thouſand plants. I have deſcribed with him on the ſpot twelve hundred ſpecies, great part of which appeared to us to belong to genera not deſcribed by Aublet, Jacquin, Mutis, or Dombey. We have collected inſects, ſhells, and different kinds of wood proper for dyeing; we have diſſected crocodiles, lamantins, apes, and the gymnotus electricus, the fluid of which is abſolutely galvanic and not electric; and have deſcribed a great many ſerpents, lizards, and fiſh.

I have made drawings of a great number of objects; in a word, I flatter myſelf that if I have erred it is rather through ignorance than want of activity. What enjoyment to live in the midſt of theſe riches of nature, ſo majeſtic and grand! Behold, then, the deareſt and moſt ardent of my wiſhes gratified! Amidſt the thick foreſts of the Rio-Nigro; ſurrounded by ferocious tygers and crocodiles; my body tormented with the ſtings of the formidable moſkitos and ants; having had for three months no other aliment than water, bananas, and manioc, among the Otomaqua Indians, who eat earth; or on the banks of the Caſquiara, under the equator, where, in the courſe of a hundred and thirty leagues, no human being is ſeen;—in all theſe embarraſſing ſituations I never repented of my undertakings: my ſufferings have been great, but they were only momentary.

When I left Spain I intended to proceed directly to Mexico, thence to Peru and the Philippines; but a malignant fever, which broke out in our frigate, induced me to remain on this coaſt of South America; and, thinking it poſſible to penetrate thence into the interior, I undertook two journeys, one to the miſſions of the Chayma Indians of Paria, and the other to that vaſt country ſituated to the north of the river of the Amazons, between Popayan and the mountains of the French part of Guyana. We twice paſſed the grand cataracts of the Orenoquo, and thoſe of Atures and Maypura, in lat. 50° 12′ and long. 5° 39′, W. dep. from Paris 4° 43′ and 4° 41′ 40″. From the mouth of the Guaviara and the rivers Atabapo, Temi, and Tuamini, I cauſed my pirogua to be carried by land as far as the Rio-Nigro, while we followed on foot through foreſts of Hevea, Cinchona, and Canella Wintertona. I deſcended the Rio-Nigro as far as Saint Carlos * that I might determine its longitude by Berthoud's

* The error in the latitude (d'Anville's chart) is more than two degrees, as it had never been determined by aſtronomical inſtruments.

time-

time-keeper, with which I am ſtill well ſatisfied. I aſcended the Caſquiara inhabited by the Ydapaminares, who eat nothing but ants dried in the ſmoke. I penetrated to the ſources of the Orenoquo, even beyond the volcano of Duida, or as far as the ferocity of the Guaica and Guaharribo Indians would permit me to venture, and I deſcended the whole of the Orenoquo, by the force of its current, as far as the capital of Guyana; performing a journey of 500 leagues in twenty-ſix days, without counting thoſe on which we ſtopped.

My health has withſtood all the fatigues of a journey of more than 1300 leagues; but my poor companion, C. Bonpland, had nearly fallen a victim to his zeal and devotion for the ſciences. After our return, he was attacked by a violent fever, accompanied with a dangerous vomiting; which, however, was ſpeedily cured.

The river of the Amazons has been inhabited for 200 years by Europeans; but on the Orenoquo and the Rio-Nigro, it was only about thirty years ago that the Europeans ventured to form a few ſettlements beyond the cataracts. Thoſe which exiſt do not comprehend above 1800 Indians, from the eighth degree to the equator; and there are no other whites than ſix or ſeven miſſionary monks, who did every thing they could to facilitate our journey.

From St. Thomas, the capital of Guyana, lat 8° 8′ 24″, long. 4° 25′ 2″, we croſſed once more the great deſert called Elanos, inhabited by wild cattle and horſes. I am now employed in conſtructing a map of the country through which I have travelled. I have been ſo fortunate as to make aſtronomical obſervations in fifty-four places. I obſerved at Caraccas, Cumana, and Tuy, twelve eclipſes of the ſatellites of Jupiter; an eclipſe of the ſun on the 28th of October 1799. By theſe means, and the chronometer, I flatter myſelf I ſhall be able to give a very exact map. We ſhall embark here at length for the Havannah, from which we ſhall proceed to Mexico.—Such is the ſummary of my travels. I know that you, Chaptal, Vauquelin, Guyton, are all intereſted in my fate; and for that reaſon I am not afraid of tiring you.

We have ſcarcely any communication here with Europe. I have often attempted to write to you, as well as to our friends Vauquelin and Chaptal. I have ſent you ſome experiments on air, and the cauſe of miaſmata. I have ſent to Delambre and Lalande, extracts from my ſmall aſtronomical obſervations. Have any of theſe reached the place of their deſtination? By the conſul of the republic at Saint Thomas I tranſmitted to you the milk of a tree which the Indians call the *cow*, becauſe they drink this milky juice,

which is not at all prejudicial, but exceedingly nouriſhing. By the help of the nitric acid I have made caoutchouc, and I mixed ſoda with that deſtined for you, according to the principles which you yourſelf fixed.

In the month of January laſt we ſent, by the corvette Philippina, a collection of ſeeds for the *Jardins des Plantes* at Paris. We know they have arrived, and muſt have been delivered to citizens Juſſieu and Thouin by the ambaſſador of the republic at Madrid. By the flag of truce, which we expect here from Guadaloupe, the muſæum will receive other articles; for at preſent we muſt be ſatisfied with preſenting you a few objects for your chemical analyſis.

I have procured for you the *curare*, or celebrated poiſon of the Indians on the Rio-Nigro. I undertook a journey to Enneralda on purpoſe to ſee the liane, which produces this juice, but unfortunately we found it without flowers; and to ſee the method practiſed by the Catarapeni and Maquiritares Indians for making this poiſon. I ſhall give you, ſome other time, a more ample deſcription of it. I ſhall only add, that I ſend you the *curare* in a box of tin plate *, and the branches of the plant *maracury*, which produces the poiſon. This liane grows, but not in great abundance, among the granitic mountains of Guandia and Yumariquin, under the ſhade of the theobromacacao and the caryocar. The Indians take off the epidermis and make an infuſion of it cold, having firſt expreſſed the juice; they then leave the water over the epidermis half expreſſed, and afterwards filter the infuſion. The filtered liquor is yellowiſh: it is then baked, and concentrated by evaporation and inſpiſſation to the conſiſtence of molaſſes. This matter contains already the poiſon, but not being ſufficiently thick to daub over the points of their arrows, they mix it with the glutinous juice of another tree, which they call *kiracaguero*. This mixture is again baked till the whole is reduced to a browniſh maſs. You know that the *curare* is taken internally as a ſtomachic: it is not noxious but when it comes into contact with the blood, which it deoxydates. It is only a few days ago that I began to make experiments upon it, and I have found that it decompoſes atmoſpheric air. I beg you will try to de-oxydate with it the metallic oxyds, and that you will examine whether the experiments of Fontana were properly made.

I add to the *curare* and the *maracury*, the *dapitche*, the *leche de pindare*, and the earth of the Otomaquas. The *dapitche* is a ſtate of the elaſtic gum, which, is, no doubt, un-

* This box, and the other articles announced here, have not yet reached C. Fourcroy.

known

known to you. We discovered it in a place where there is no hevea, in the marshes of the mountain of Javita, lat. 2° 5′, which are famous on account of the terrible serpents, of the boa kind, found in them.

Among the Pormisano and Paragini Indians we saw musical instruments made of the caoutchouc, and the inhabitants told us they found it in the earth. The *dapitche* or *zapir* is really a spongy white mass found under the roots of two trees, which appeared to us of a new genus, the *jacio* and the *curvana*, and of which we shall one day give a description. The juice of these trees is a very aqueous milk, but it appears that it is a malady in these trees to lose the juice by the roots. This discharge causes the tree to perish, and the milk coagulates in the moist earth, where it is preserved from the contact of the air. I send you the *dapitche* itself, and a mass of caoutchouc made from it, merely by exposing it to heat or dissolving it over the fire. This production, and the milk of the *cow*, in your hands, will serve to throw new light on this substance, so curious in a physiological point of view.

The *leche de pindare*, which is the dried milk of a pindar-tree, is a natural white varnish. The Indians cover their vessels and *tacuma* with this milk when it is fresh. It dries speedily, and forms a very beautiful varnish; but, unfortunately, it becomes yellow when dried in a large mass; and it is in this state that I send it to you.

In regard to the earth of the Otomaquas, I must observe that this nation, so hideous by the paintings which disfigure their bodies, when the Orenoquo is very high, and they can find no tortoises, for three months eat scarcely any thing but a kind of fat earth. There are some of them who eat a pound and a half of it per day. Some of the monks assert that they mix with it the fat of the tails of crocodiles: but this is false. We found among the Otomaquas stores of the pure earth which they eat: they give it no other preparation than that of burning it slightly, and rendering it moist. It appears to me astonishing that people can be robust and eat a pound and a half of earth daily, while we find that earth produces a very pernicious effect among children. My own experiments on earths and their properties, however, give me reason to suspect that they may be nourishing; that is to say, that they may act by affinities.

I add for the musæum, because it has fallen into my hands, the smoking instrument of the Otomaquas, and a shirt of the Piroas, a neighbouring nation. This smoking instrument is none of the smallest, as you will see. It is a kind of plate,

on which they place the raſped and rotten fruit of a mimoſa, mixed with ſalt and a little quick-lime. The Otomaqua holds the plate in one hand and in the other the tube, the two ends of which enter his noſtrils, that he may inhale this ſtimulating tobacco. This inſtrument has a hiſtorical intereſt: it is common only to the Otomaquas and the Omeguas, two nations who at preſent are 300 leagues diſtant from each other, among whom Condamine ſaw it. It proves that the Omeguas, who, according to an old tradition, came from Guaviara, may be deſcended from the Otomaquas, and that the city of Manoa was ſeen by Phillip de Vure between Meta and Guaviara. Theſe facts are intereſting in regard to the origin of the fable of the *Dorado*.

The ſhirt, which one of my people wore for a long time, is the bark of the tree called *morima*, without any preparation. You ſee that ſhirts grow upon trees in this country, and near the Dorado, where I found no mineral curioſities but talc and a little titanium.

It has been impoſſible for us to arrange the ſeeds and plants of the Rio-Nigro deſtined for Thouin, Juſſieu, and Desfontaines, who will not altogether have forgotten me. We have very uncommon things; for example, new kinds of *befaria*, new genera of palms; all which we ſhall ſoon diſpatch, and be aſſured that we ſhall not loſe ſight of the intereſts of the muſæum. But alas! captain Baudin has ſet out, and we are here! This is very hard and diſtreſſing. We ſhall perhaps find him in the South Sea.

I beg you will remember me to the reſpectable members of the National Inſtitute: my reſpects to Berthollet, Chaptal, Vauquelin, Guyton, Juſſieu, Desfontaines, Halley, Delambre, Laplace, Cuvier. In the letter which I ſend to Delambre I forgot an eclipſe, which I beg you will add to it.

Immerſion of the 3d ſatellite on the 4th of October 1800, at Cumana, at 16 h. 59′ 36″ mean time.

P. S. Repeat, I beg of you, my requeſt to the Board of Longitude for the *Connoiſſances des Tems*. I regret the death of general Deſaix. What a loſs to the republic and all mankind!

II. *A Treatiſe*

II. *A Treatiſe on the Cultivation of the Vine, and the Method of making Wines.*

[Continued from Vol. IX. p. 342.]

III. General Precepts reſpecting the Art of managing Fermentation.

WHEN the grapes have acquired the proper degree of maturity, if the atmoſphere be not too cold, and if the vintage be of the proper volume, fermentation has no need of aid or aſſiſtance. But theſe conditions, without which it is impoſſible to have a good reſult, are not always united, and it belongs to art, in order to obtain a good fermentation, to combine all theſe favourable circumſtances, and to remove every thing prejudicial.

The faults of fermentation ariſe naturally from the quality of the grapes, which is the ſubject of it; and from the temperature of the air, which may be conſidered as a very powerful auxiliary.

Grapes may not contain a ſufficiency of ſugar to produce a ſufficient formation of alcohol: and this vice may be owing to the grapes not having attained to maturity, or to the ſugar being diluted in too conſiderable a quantity of water; or becauſe ſugar, by the nature of the climate, cannot ſufficiently develop itſelf. In all caſes there are two ways of correcting the vice which exiſts in the nature of the grapes; the firſt conſiſts in conveying into the muſt that principle which it wants: a proper addition of ſugar preſents to fermentation the materials neceſſary for the formation of alcohol, and the deficiency of nature is ſupplied by art. The antients, it appears, were acquainted with this proceſs, ſince they mixed honey with the muſt which they cauſed to ferment. At preſent, direct experiments have been made on this ſubject; but I ſhall confine myſelf to tranſcribe here the reſults of thoſe made by Macquer.

"In the month of October 1776 I procured from a garden at Paris a quantity of the white grapes called *pineau* and *mélier* ſufficient to make from twenty-five to thirty quarts of wine. They were waſte grapes, and taken, purpoſely, in a bad ſtate of maturity, that there might be no hopes of making potable wine from them: in nearly about a half of them, ſingle grapes and even whole cluſters were ſo green that their acidity was inſupportable. Without taking any other precaution than to ſeparate what were putrid, I cauſed the reſt to be bruiſed with the ſtalks, and the juice to be expreſſed

expreſſed with the hand: the muſt which iſſued from them was exceedingly turbid, of a dirty-green colour and of a ſweetiſh ſour taſte, in which the acid predominated ſo much that it cauſed thoſe who taſted it to make wry faces. I diſſolved in this muſt a ſufficient quantity of brown ſugar to give it the taſte of pretty good ſweet wine; and, without boiler, funnel, or furnace, I put it into a caſk in an apartment at the bottom of the garden, where it was left to itſelf. Fermentation took place in it on the third day, and maintained itſelf for eight days in a very ſenſible manner, but ſtill very moderate. After that time it ceaſed ſpontaneouſly.

"The wine thence reſulting being newly made, and ſtill turbid, had a pretty ſtrong and pungent vinous odour; its taſte was ſomewhat harſh; while that of the ſugar had diſappeared as completely as if it had never exiſted. I ſuffered it to remain in the caſk during the winter; and having examined it in the month of March, I found that, without having been drawn off or ſtrained, it had become clear; its taſte, though ſtill pretty ſtrong and pungent, was, however, much more agreeable than it had been immediately after the ſenſible fermentation; it had ſomething ſweeter and more racy, but was mixed with nothing that approached to ſugar. I then put the wine in bottles, and having examined it in the month of October 1777, I found it to be clear, fine, exceedingly brilliant, agreeable to the taſte, generous, and warm; in a word, like good white wine made from pure grapes which has nothing luſcious, the produce of a good vineyard in a good year. Several connoiſſeurs, whom I made to taſte it, gave it the ſame character, and could not believe that it had been made from green grapes, the taſte of which had been corrected with ſugar.

"This ſucceſs, which exceeded my hopes, induced me to make a new experiment of the ſame kind, and ſtill more deciſive, on account of the extreme greenneſs and the bad quality of the grapes which I employed.

"On the 6th of November 1777 I cauſed to be collected, from the top of an arbour in a garden at Paris, a kind of large grapes which never ripen properly in this climate, and which we know only under the name of *verjus*, becauſe they are uſed for no other purpoſe than to expreſs the juice before it becomes ſpoiled, that it may be employed as a kind of ſour ſeaſoning in cookery. Thoſe here alluded to had ſcarcely begun to rot though the ſeaſon was far advanced, and they had been abandoned on the arbour as leaving no hope of their acquiring ſufficient maturity to be fit for the table. They were ſtill ſo hard that I reſolved to make them burſt over the

fire

fire in order to extract the juice: the quantity they furniſhed was about eight or nine quarts. This juice had a very acid taſte, in which there could ſcarcely be diſtinguiſhed a very ſlight ſaccharine ſavour. I diſſolved ſome of the commoneſt caſſonade until it appeared to me to be very ſaccharine. I required a great deal more than for the wine of the preceding experiment, becauſe the acidity of the latter muſt was much ſtronger. After the ſugar was diſſolved, the taſte of the liquor, though very ſaccharine, had nothing agreeable, becauſe the ſweet and the ſour were perceived pretty ſtrongly and ſeparately in a diſagreeable manner.

"I put this kind of muſt into a jar ſo as not to be entirely full, and covered it only with a cloth: as the ſeaſon was already very cold, I placed it in an apartment where the heat was always maintained at 12 or 13 degrees (59 to 61 F.) by means of a ſtove.

"Four days after the fermentation was not yet very ſenſible, the liquor appeared to me to be as ſaccharine and as acid; but theſe two taſtes beginning to be better combined, the reſult was a whole more agreeable to the taſte.

"On the 14th of November the fermentation was in full force: a lighted taper introduced into the empty part of the jar, was ſpeedily extinguiſhed.

"On the 30th the ſenſible fermentation had entirely ceaſed, and the taper was no longer extinguiſhed in the interior of the jar. The wine which reſulted from it was, however, very turbid and whitiſh; its taſte had ſcarcely any thing ſaccharine; it was ſtrong, pungent, and pretty agreeable, like that of generous warm wine, but a little gaſeous and green.

"I cloſed the jar and put it into a cool place, that the wine might bring itſelf to perfection by inſenſible fermentation during the whole winter.

"Having examined this wine on the 17th of March 1778, I found that it was almoſt entirely clear, the remains of its ſaccharine as well as its acid taſte had diſappeared. The latter was that of pretty ſtrong wine made from pure grapes: it was not unpleaſant, but had no perfume or *bouquet*, becauſe the grapes, which we call *verjus*, contain no odorous principle or aroma: theſe excepted, this wine, which was quite new, and which ſtill had to gain by that fermentation which I call *inſenſible*, promiſed to become racy and agreeable."

Theſe experiments ſeem to me to prove, beyond all doubt, that the beſt method of remedying the want of maturity in grapes is to follow the proceſs indicated by nature; that is to ſay, to introduce into the muſt that quantity of ſaccharine principle neceſſary which it could not give them. This me-

thod

thod is the more practicable, as not only ſugar, but alſo honey, molaſſes, and every other ſaccharine matter of an inferior price can produce the ſame effect, provided they have no diſagreeable acceſſary taſte which cannot be deſtroyed by good fermentation.

Bullion cauſed the juice of grapes, taken from his park at Bellegames, to ferment by adding from 15 to 20 pounds of ſugar per *muid* *. The wine they produced was of a good quality.

Rozier, long ago, propoſed to facilitate the fermentation of muſt, and ameliorate wines by the addition of honey, in the proportion of a pound to two hundred of muſt. All theſe proceſſes depend on the ſame principle, viz. that no alcohol is produced where there is no ſugar; and that the formation of alcohol, and conſequently the generous nature of wine, is conſtantly proportioned to the quantity of ſugar exiſting in the muſt: it is thence evident that wine may be carried to any degree of ſpirituoſity required, whatever may be the primitive quality of the muſt, by adding to it more or leſs ſugar.

Rozier has proved, and the ſame reſult may be obtained by calculating the experiments of Bullion, that the value of the produce of the fermentation is very far ſuperior to the price of the matters employed; ſo that theſe proceſſes may be preſented as objects of œconomy and matter of ſpeculation.

It is poſſible alſo to correct the quality of the grapes by other means, which are daily practiſed. A portion of the muſt is boiled in a kettle; it is concentrated to one-half, and then poured into a vat: by this method the aqueous portion is in part diſſipated, and the portion of ſugar being then leſs diluted, the fermentation proceeds with more regularity, and the produce is more generous. This proceſs, almoſt always uſeful in the north, cannot be employed in the ſouth, but when the ſeaſon has been rainy or when the grapes have not been ſufficiently ripe.

The ſame end may be attained by drying the grapes in the ſun, or expoſing them for the ſame purpoſe in ſtoves, as is practiſed in ſome wine countries.

It is perhaps for the ſame reaſon, always with a view to abſorb the moiſture, that plaſter is ſometimes put into the vat, as was practiſed by the antients.

It ſometimes happens that the muſt is both too thick and too ſaccharine: in that caſe the fermentation is always ſlow and imperfect; the wines are ſweet, luſcious, and thick; and it is not till after remaining a long time in the bottles that

* 280 quarts.

it

it becomes clear, loſes its diſagreeable thickneſs, and only exhibits good qualities. The greater part of the white Spaniſh wines are in this ſituation. This quality of wine has however its partiſans, and there are ſome countries where the muſt is concentrated for that purpoſe, in others the grapes are dried in the ſun or in ſtoves till they are reduced almoſt to the conſiſtence of an extract.

It would be eaſy in all caſes to excite fermentation, either by diluting the muſt, when too thick, with water, or by agitating the vintage in proportion as it ferments: but all this muſt be ſubordinate to the end propoſed to be obtained, and the intelligent agriculturiſt will vary his proceſſes according to the effect which he intends to produce.

It muſt never be forgotten, that the fermentation ought to be managed according to the nature of the grapes and agreeably to the quality of the wine that may be required. Burgundy grapes cannot be treated like thoſe of Languedoc. The merit of the one conſiſts in a peculiar flavour, which would be diſſipated by a ſtrong and lengthened fermentation: that of the other in the great quantity of alcohol which may be developed in them; and here the fermentation in the vat muſt be long and complete. In Champagne, the grapes deſtined for the white briſk wines are collected in the morning before the ſun has cauſed all the moiſture to evaporate; and in the ſame country the grapes deſtined for making red wine are not cut until they have been well dried by the rays of the ſun. In one place artificial heat is neceſſary to excite fermentation, in another the nature of the muſt is ſuch that the fermentation would require to be moderated. Weak wines muſt be fermented in caſks, ſtrong wines ought to be ſuffered to work in the vat. Every country has proceſſes preſcribed to it by the nature of its grapes, and it is highly ridiculous to attempt ſubmitting every thing to a general rule. It is of importance to be well acquainted with the nature of the grapes employed and with the principles of fermentation: by the help of this knowledge a ſyſtem of conduct may be formed which cannot fail of being highly advantageous, becauſe it is founded not on hypotheſis but on the nature of things.

In cold countries, where the grapes are very aqueous and little ſaccharine, they ferment with difficulty: fermentation in that caſe may be excited by two or three principal means:

1ſt, By the help of a funnel of tin plate with a very wide tube, which deſcends to within four inches of the bottom of the vat, and through which boiling muſt is introduced into it. Two pailfuls may be uſed for 300 bottles of muſt. This proceſs, propoſed by Maupin, has produced good effects.

2d, By ſhaking the vintage from time to time: this motion is attended with this advantage, that it renews the fermentation when it has ceaſed or become weak, and cauſes it to be uniform throughout the maſs.

3d, By laying a covering not only over the vintage, but round about the vat.

4th, By heating the atmoſphere of the place in which the vat ſtands.

It often happens that the working of the vintage ſlackens, or that the heat is unequal through the maſs: it is to obviate theſe inconveniences, eſpecially in cold countries, where they are more frequent, that the vintage is from time to time trod upon. Gentil made two vatfuls, of eighteen butts each, and with grapes from the ſame vines, and collected at the ſame time: the grapes were freed from the ſkins, ſtalks, &c. and bruiſed; the juice of both was perfectly equal in quality, and the vintage was put into vats of equal ſize: the weather, but particularly in the morning and at night, was exceedingly cold.

At the end of ſome days the fermentation began: it was obſerved that the centre of the vats was exceedingly warm and the edges very cold; the vats were ſo cloſe as to touch each other, and both experienced the ſame temperature. They were preſſed down with a long pole. The cold vintage was puſhed from the edges towards the centre where the heat was ſtrongeſt: it was preſſed down ſeveral times, and by theſe means an equal heat was maintained throughout the whole maſs. The fermentation in the vat where this proceſs had been followed was finiſhed twelve or fifteen hours ſooner than in the other. The wine was far better, it was more delicate, had a ſuperior taſte, and was more highly coloured and more generous. No one would have ſaid that it was produced from the ſame grapes.

The antients mixed aromatic ſubſtances with the vintage in a ſtate of fermentation, in order to give their wines peculiar qualities. We are told by Pliny that it was uſual in Italy to ſprinkle pitch and reſin over the vintage *ut odor vino contingeret et ſaporis acumen.* In all the works of that period we find numerous recipes for perfuming wines; but theſe different proceſſes are no longer uſed. I am, however, inclined to think that they were of great benefit. This very important part of oinology deſerves the particular attention of the agriculturiſt. When we conſider the cuſtom followed in ſome countries of perfuming the wines with raſpberries, the dried flowers of the vine, &c. we may even preſage the happieſt effects from it.

Darcet

Darcet has communicated to me the following facts, which I take the earlieſt opportunity of publiſhing here, as they may give riſe to experiments proper for improving the art of vinification.

" I took," ſays he, " a caſk called half a *muid*, which I filled with the juice of untrod grapes, and ſuch as had run of itſelf from the grapes as carried from the vineyard to the preſs: it therefore had very little colour.

" This caſk contained about 150 quarts. I took about thirty quarts, which I evaporated and concentrated to nearly about one-eighth of the volume of the liquor; four pounds of common ſugar were added, and a pound of grapes *de careme*, after care had been taken to bruiſe them: the whole, ſomewhat warm, was then put into the caſk, which was filled up with the ſame muſt that had been kept apart. A bunch, of about half an ounce, of abſinthium, dried and well preſerved, was then put into the caſk, and the caſk was ſlightly covered, with its lid inverted: fermentation ſoon took place, and proceeded in a briſk and free manner.

" Beſides this piece of muſt, I cauſed to ferment alſo a jar of the ſame containing about twenty-five or thirty quarts, with half an ounce of ſugar per quart: this wine fermented very well in this jar, and it ſerved me for filling up during the fermentation and after the firſt drawing off, which was performed at the uſual time, and repeated a year after: it was afterwards put into bottles at the expiration of a year, or in the following winter.

" This wine was made in September 1788, during fine weather, and in a very good year.

" It kept very well even in the bottle, it neither became ſour nor turbid at the end of ſeveral days; I have ſtill two or three bottles of it: it begins to fade."

IV. Ethiology of Fermentation.

The phænomena and reſults of fermentation are ſo highly intereſting in the eyes of the chemiſt and the agriculturiſt, that, after having conſidered them merely under a practical point of view, we muſt now conſider them under the relation of ſcience.

The two phænomena which ſeem moſt worthy of attention from the chemiſt, are the diſappearance of the ſaccharine principle and the formation of alcohol.

As in fermentation there is no abſorption of air, nor addition of any foreign matter, it is evident that all changes

which take place in the operation can be referred only to the departure of thoſe ſubſtances which are volatiliſed or precipitated.

Thus, by ſtudying the nature of theſe ſubſtances, and aſcertaining their conſtituent principles, it will be eaſy for us to judge of the changes which muſt have been produced in the nature of the firſt materials of fermentation.

The materials of fermentation are the ſweet and ſaccharine principle diluted in water. This principle is formed of ſugar and extractive matter.

The ſubſtance volatiliſed is the carbonic acid gas, and that precipitated is a matter analogous to the ligneous fibre mixed with potaſh.

The principal product of fermentation is alcohol.

It is evident that the tranſition of the ſaccharine principle to alcohol cannot be conceived but by calculating the difference which muſt be produced in the ſaccharine principle by the departure of the principles that form carbonic acid gas which is volatiliſed, and the depoſit which is precipitated.

Theſe principles are, in particular, the carbon and the oxygen: here, then, we find carbon and oxygen taken from the ſaccharine principle by the progreſs of fermentation; but in proportion as the ſaccharine principle loſes its oxygen and its carbon, the hydrogen, which forms the third conſtituent principle, remaining the ſame, the characters of the latter element muſt predominate, and the fermenting maſs muſt attain to that point at which it will only preſent an inflammable fluid.

In proportion as the alcohol is developed, the liquid changes its nature; it no longer has the ſame affinities, nor, conſequently, the ſame diſſolving power. The ſmall quantity of extractive principle which remains after having eſcaped decompoſition is precipitated with the carbonat of potaſh: the liquor becomes clear, and the wine is made.

Vinous fermentation, then, is nothing but the continued departure of carbon and oxygen, which produces on one hand the carbonic acid, and on the other alcohol. The celebrated Lavoiſier ſubjected to calculation all the phænomena and reſults of vinous fermentation, comparing the products of the decompoſition with its elements. He aſſumed as the baſis of his calculations the data furniſhed to him by analyſis both in regard to the nature and the proportions of the conſtituent principles before and after the operation. We ſhall here tranſcribe the reſults obtained by this great man.

Materials

Materials of Fermentation for a Quintal of Sugar.

		lib.	*oz.*	*dr.*	*gr.*
Water		400	0	0	0
Sugar		100	0	0	0
Yeaſt of beer in paſte compoſed of	Water	7	3	6	44
	Dry yeaſt	2	12	1	28
	Total	510	0	0	0

Detail of the conſtituent Principles of the Materials of Fermentation.

lib.	*oz.*	*dr.*	*gr.*		*lib.*	*oz.*	*dr.*	*gr.*
407	3	6	44	Of water compoſed of				
				Hydrogen	61	1	2	71·40
				Oxygen	346	2	3	44·60
100	0	0	0	Sugar compoſed of				
				Hydrogen	8	0	0	0
				Oxygen	64	0	0	0
				Carbon	28	0	0	0
2	12	1	28	Dry yeaſt compoſed of				
				Carbon	0	12	4	59·00
				Azot	0	0	5	2·94
				Hydrogen	0	4	5	9·30
				Oxygen	1	10	2	28·76
				Total	510	0	0	0

Recapitulation of the conſtituent Principles of the Materials of Fermentation.

		lib.	*oz.*	*dr.*	*gr.*	*lib.*	*oz.*	*dr.*	*gr.*
Oxyg.	Of the water	340	0	0	0				
	Of the water of the yeaſt	6	2	3	44·60				
	Of the ſugar	64	0	0	0				
	Of the dry yeaſt	1	10	2	28·76	411	12	6	1·36
Hydr.	Of the water	60	0	0	0				
	Of the water of the yeaſt	1	1	2	71·40				
	Of the ſugar	8	0	0	0				
	Of the yeaſt	0	4	5	9·30	9	6	0	8·70
Carb.	Of the ſugar	28	0	0	0				
	Of the yeaſt	0	12	4	59·10	28	12	4	59·00
Azot of the yeaſt						0	0	5	2·94
					Total	510	0	0	0

Table of the Results obtained by Fermentation.

lib. oz. dr. gr.		*lib. oz. dr. gr.*
35 5 4 19 Of carbonic acid, composed of	Oxygen - -	25 7 1 34
	Carbon - -	9 14 2 57
408 15 5 14 Of water, composed of	Oxygen - -	347 10 0 59
	Hydrogen - -	61 5 4 27
57 11 1 58 Of dry alcohol, composed of	Oxygen combined with hydrogen -	31 6 1 64
	Hydrogen combined with hydrogen -	5 8 5 3
	Hydrogen combined with carbon -	4 0 5 0
	Carbon - -	16 11 5 63
2 8 0 0 Of dry acetous acid, composed of	Hydrogen - -	0 2 4 0
	Oxygen - -	1 11 4 0
	Carbon - -	0 10 0 0
4 1 4 3 Of saccharine residuum, composed of	Hydrogen - -	0 5 1 67
	Oxygen - -	2 9 7 27
	Carbon - -	1 2 2 53
1 6 0 50 Of dry yeast, composed of	Hydrogen - -	0 2 2 41
	Oxygen - -	0 13 1 14
	Carbon - -	0 6 2 30
	Azot - - -	0 0 2 37
510 0 0 0		510 0 0 0

Recapitulation of the Results obtained by Fermentation.

lib. oz. dr. gr.		*lib. oz. dr. gr.*
409 10 0 54 Oxygen -	Of the water - -	347 10 0 59
	Of the carbonic acid	25 7 1 34
	Of the alcohol -	31 6 1 64
	Of the acetous acid	1 11 4 0
	Of the saccharine residuum	2 9 7 27
	Of the yeast - -	0 13 1 14
28 12 5 59 Carbon -	Of the carbonic acid	9 14 2 57
	Of the alcohol -	16 11 5 63
	Of the acetous acid -	0 10 0 0
	Of the saccharine residuum	1 2 2 53
	Of the yeast - -	0 6 2 30
438 6 6 41		438 6 6 41

lib.

lib.	*oz.*	*dr.*	*gr.*		*lib.*	*oz.*	*dr.*	*gr.*
438	6	6	41	Brought over	438	6	6	41
				Of the water - -	61	5	4	27
				Of the water of the alcohol	5	8	5	3
71	8	6	66	Combined with the carbon				
Hydrogen				in the alcohol -	4	0	5	0
				Of the acetous acid -	0	2	4	0
				Of the ſaccharine reſiduum	0	5	1	67
				Of the yeaſt - -	0	2	2	41
0	0	2	37					
Of Azot			-	- - - -	0	0	2	37
510	0	0	0		510	0	0	0

By reflecting on the reſults exhibited by theſe tables, we may clearly ſee what takes place in the vinous fermentation: it is firſt obſerved that, of the 100 pounds of ſugar employed, 4 lib. 1 oz. 4 dr. 3 gr. remained in the ſtate of undecompoſed ſugar; ſo that the quantity of ſugar really ſubjected to operation was only 95 lib. 14 oz. 3 dr. 69 gr.; that is to ſay, 61 lib. 6 oz. 45 gr. of oxygen, 7 lib. 10 oz. 6 dr. 6 gr. of hydrogen, and 26 lib. 13 oz. 5 dr. 19 gr. of carbon. But by comparing the quantities it will be found that they are ſufficient to form all the ſpirit of wine, all the carbonic acid, and all the acetous acid, produced by the fermentation.

The effects of vinous fermentation are reduced, then, to the ſeparating into two portions the ſugar, which is an oxyd; oxygenating the one at the expenſe of the other to form carbonic acid; deoxygenating the other in favour of the former to produce a combuſtible ſubſtance, which is alcohol; ſo that, if it were poſſible to combine theſe two ſubſtances, the alcohol and carbonic acid, ſugar would be re-formed. It is to be obſerved alſo, that the hydrogen and carbon are not in the ſtate of oil in the alcohol; they are combined with a portion of oxygen, which renders them miſcible with water: the three principles, oxygen, hydrogen, and carbon, are here, then, ſtill in a kind of ſtate of equilibrium; and, indeed, by making them paſs through an ignited glaſs or porcelain tube, they may be re-combined two and two, and water and hydrogen, carbonic acid and carbon, are again found.

[To be continued.]

III. *Luminous Appearance of Ocean-Water caused by Animals: in a Letter from Professor* MITCHILL, *of New-York, to Professor* BARTON, *of Philadelphia* *.

So obvious an appearance as the phosphorescence of ocean-water was ascribed to animals as long ago as the time of Pliny. Some of these adhering to the rigging of vessels in windy and stormy weather, and shining in the dark, seem to have caused the appearances known formerly by the names of Castor and Pollux. Much has been offered on this subject, both physically and historically, you know, by Charles Frederic Adler, in his *Dissertatio de Noctiluca Marina*, which is well worthy of perusal. He has given a magnified figure of a microscopic worm, which, in the sea of China, makes the salt water luminous. It is called by some French writers *scolopendre marine luisante*, and by Linné *nereis noctiluca*. Some of the sea-jellies and sea-blubbers have also been long known to be occasionally luminous. The principal part of these are *meduſas*, which, at a very early day, obtruded themselves on the attention of naturalists. But, notwithstanding all this, the philosophical world seems still to be a good deal undecided as to the real cause of the phosphorescence of the ocean. I have therefore recorded the following facts, which fell under my own eye, hoping they may not be without their use in explaining the phænomenon. Pennant, in his British Zoology, vol. iv. expresses very just ideas on the subject.

On the evening of Saturday, the 13th of September 1800, about high water, as we were preparing, between seven and eight o'clock, to bathe in the bay, my attention was called to a remarkable luminous appearance at the water's edge on the beach. The wind was from the southward, and the day had been so warm, that about two P. M. the quicksilver in a thermometer hanging in a shaded piazza, on the south side of the house, had risen to 89 degrees. At this moment it stood as high as 76. The distance from the chamber windows to high water mark is 210 feet. It seemed as if the beach was covered with coals of fire, and that bright sparkles were constantly emitted among them. The small undulation which moved to land looked like a wave of flame rolling along the shore; and the water beyond, to the distance of a few rods, exhibited frequent corruscations of extraordinary brightness. On going down to the water, I found the sand covered with molluſca animals, the greater part of which were the *meduſa simplex*. Thousands of them had just been

* Communicated to the Editor by the Author.

left

left by the receding tide, and were yet alive. Being incapable of living long out of the water, and unable to ſurvive until the next flood, they ſeemed to be under the influence of their laſt vital movements. They lay ſo thick under foot, that at every tread many of them were cruſhed to pieces. Beſides their ſpontaneous power to become luminous, whenever they were moved they emitted light; and this happened indifferently, whether their gelatinous bodies were agitated through the medium of air, water, or the direct contact of the feet or fingers. On walking among them, and thereby exciting their luminous action, the beach reſembled melted metal in a red-hot ſtate; or the phænomenon might be compared to a radiant glory ſurrounding the feet, to the diſtance of a foot and a half, or more, at every tread. In ſeveral inſtances, the light emitted by a ſingle one, when taken, in its freſh and vivid ſtate, into my hand, was ſufficient to enable me to determine the time of night by my watch, the minute and hour hands being plainly to be ſeen: but this brightneſs was but tranſient. Frequently the creature emitted not a particle of light; and then, on a ſudden, the luminous appearance would be conſpicuous, and as quickly diſappear. The ſucceſſion of theſe lucid emanations, from the creatures lying in ſuch numbers upon the wet ſand, reſembled, if ſmall things may be compared with great, the unſteady light of the fixed ſtars; and, indeed, the twinkling of theſe phoſphoreſcent animals below, and of the celeſtial bodies above, afforded a ſpectacle ſo ſingular and ſo ſplendid, that I ſpent good part of the evening in admiring it. I remarked, alſo, that the ſand on which theſe animals were left by the tide was luminous; and found, on cruſhing them to pieces in my hand, that a faint phoſphoreſcence was imparted both to the ſand and to my ſkin: but in neither caſe did it laſt long.

But what was as ſingular as any part of the phænomenon, was the effect produced by them upon our bodies and clothes while we were bathing. Whenever the water near one of them was agitated, a large fire-ball ſeemed to burſt upon the view beneath the water; and whenever this happened in contact with one of the limbs, cauſed ſome of us inſtantaneouſly almoſt to ſtart, for fear of being burned. Where any of the ſlimy matter was left, ſomewhat of a luminous appearance was perceptible on our clothes, giving them and our ſkins ſometimes the appearance of phoſphoric ſpots, and ſometimes the more extraordinary ſemblance of being painted over with liquid fire. There were more than one ſpecies of animal; for beſides thoſe which, by their magnitude, were very plain ſubjects for examination, there were ſome luminous ſpots as

ſmall as points, and as minute as the eye could diſcern. Theſe adhered to our clothes and ſkins, and, when taken up with the water in veſſels of glaſs, were too ſmall or too pellucid to be diſtinguiſhed by the naked eye, though they contributed eminently towards the effect of this ſubmarine illumination. This, I preſume, was the *nereis noctiluca*, an inteſtinal animal. I ſucceeded in diſcovering another ſpecies, which was a ſlender worm of about a quarter of an inch long, and emitted, at times, a bright light of a greeniſh hue. This was probably a larger ſpecies of nereis.

Not being well acquainted with the nature of thoſe molluſca-beings, I apprehended ſome inconvenience from ſuch a maſs of animal matter left on the ſhore to putrefy ſo near the houſe. But my cauſe of alarm vaniſhed before the next riſing ſun: for, during the receſs of the tide, they all periſhed; though, inſtead of remaining a great maſs of dead gelatinous creatures on the beach, this whole collection of living animals, whoſe vivid exhibitions of light evinced their being alive near midnight, had ſo totally diſappeared before four o'clock, that no other trace of their having been there could be diſcerned, than ſome phoſphoreſcence in the ſand, on being ſtirred up by the foot or taken up in the hand. They had loſt their organiſation, and, in ſo ſhort a time, diſſolved into a kind of ſlime, which penetrated the ſand, and was mingled with the water of the next flood. On examining the ſpots at ſix o'clock next morning, before the beach was covered by the tide, not a veſtige of one of this numerous ſhoal of animals was diſcoverable by day-light. A ſpectator of the morning ſcene could not have known, by any thing diſcernible, that ſuch a brilliant exhibition had been made there the preceding evening, or that a ſingle animal had been caſt aſhore on the ſpot.

I put ſeveral of the larger ſpecies of theſe creatures into glaſſes of their native ſalt water, and carried them into my chamber. During the night I made repeated obſervations upon them, and found that the light they afforded was neither perpetual nor extended to their whole bodies. It was intermitting, and confined to certain lines paſſing from one extremity of the creature to another. The light was of a blueiſh colour, and the ſtreams of it were highly beautiful. Theſe animals lived all night in the water, and were as lively as ever in the morning. They were almoſt tranſparent, and nearly of the colour of the fluid in which they were ſuſpended; yet, on placing them in a good light, they were found ſufficiently opaque to be diſtinctly examined. Their figure was globoſe, or rather elliptical, ſhaped like a walnut. The largeſt were

about an inch and a half in length, and the leaſt as ſmall as the eye could diſcern. Their ſtructure was too delicate to allow them to be examined in any other manner than in their floating ſtate. They were about of the ſame weight with ſea water. At their option they could readily aſcend and deſcend in it. And as they have no air-veſſels like fiſhes, they accompliſhed their riſe and fall by a mere change of their ſpecific gravity; contracting themſelves into a ſmaller volume if they wiſhed to ſink, and expanding themſelves to a wider bulk if they intended to ſwim. Before ten o'clock next morning ſeveral of them were evidently dying, and before forty-eight hours had elapſed all of them were dead, and ſo entirely diſorganiſed that not a film or membrane was left; but the water, which was a little turbid, had a ſmall mud-like ſediment, and ſmelled ſtrong of phoſphorated hydrogenous gas.

The nearneſs of their approach to pellucidity diſplayed their internal ſtructure to the eye without the trouble of anatomiſing. They might be looked through without the aid of a diſſecting inſtrument; and their blood, though not red, but nearly of the pale colour of their bodies, reflected light enough in the day-time to enable it to be ſeen in motion, briſkly circulating through the arterious and venous tubes. This view of the circulation of the blood through the whole œconomy of a healthy animal, was one of the moſt intereſting appearances in animated phyſiology that I ever had beheld. This creature, like the echinus, and many more, had no heart, but the veſſels were endowed with muſcular power enough to propel their fluids without the aid of ſuch an organ. The pulſations of the arteries could be eaſily counted, and the little waves of the circulating fluid diſtinguiſhed as they paſſed from the larger extremity, where the motion was moſt evident, to the ſmaller, where it was more evaneſcent, and terminated in correſponding veins. In theſe animals the circulation not only proceeds, as in other creatures, one while ſwiftly, and at another ſlowly, but, at times, is totally intermitted or ſuſpended, and this, ſeemingly, *ad arbitrium*. Eight large arteries received the pale blood from a common trunk, and conveyed it from one extremity toward the other. They were about equi-diſtant, and gave the animal a ſomewhat ſtriped appearance, ſuch as a ſlight intermixture of arſenic imparts to glaſs. The termination of theſe arteries in continuous veins was very plain to be ſeen, until their ramifications upon the parts which appeared to be nutritive viſcera became too minute for ſight, after which the inviſible tubes ſeemed to connect their branches into a common canal,

or vena cava, whence the eight arteries before mentioned derived their ſupply.

Such being the manner in which their juices circulated, it could now be underſtood in what part the luminous exhibition was made. I was ſoon ſatisfied it was in the arteries, and not in the veins; and the diaphanous conſiſtence of the animal permitted this light to be ſeen through its ſubſtance as plain as through cryſtal. The blood, after entering the arteries, and during its ſubjection to their action, became luminous, and paſſed through like ſtreams of ignited metal or electric emanations. And this vaſcular illumination, variouſly refracted in paſſing through the pellucid ſubſtance of the creature, through the water in which it floated, and through the atmoſphere to the eye, made the whole body, when ſeen at a diſtance, appear luminous. Theſe ſtreams of light, however, were not conſtant. They not only intermitted when the circulation of the blood was intermitted, and the action of the veſſels ſtopped; but very commonly, while the fluids were paſſing through their tubes with the utmoſt rapidity, there would be no phoſphoreſcence at all: then, again, one or more, and ſometimes all the arteries, would ſuddenly exhibit the lucid phænomenon, and the creature and the ſurrounding water flaſh with light. This luminous evolution was not confined to the nocturnal exiſtence of the animal; for, on attentively examining their functions by day, when the light was too faint to be ſeen, it could be eaſily diſtinguiſhed, by the colour of the fluid in the veſſels, that the ſame action was going on. It appeared of a blueiſh, or ſomewhat irideſcent hue, along the courſe of the arteries, though its feebler light, like that of a taper, was loſt amid the ſplendour of the ſolar rays. The ſame proceſs, however, is going on during the day-time, in theſe creatures, though unobſerved, that we behold in the dark.

One of theſe meduſas may be compared to a glaſs lanthorn, freely permitting the light produced within it to diffuſe itſelf to the ſurrounding ſpaces, while an external obſerver can thereby diſcern what is going on in the inſide. I am ſo entirely ſatisfied of the connection between this evolution of light and the circulation of arterious blood, that I want no clearer evidence to that point. It is probable that in an animal which is entirely deſtitute of lungs as well as of heart, the pulmonary function may be performed by the vital veſſels themſelves. In theſe creatures I believe this to be the fact.

The light, then, which theſe marine animals exhibit, may be concluded to be produced by a function in them analogous

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to the reſpiration of animals which are of larger ſize and more complicated ſtructure. The only reaſon why it is viſible from their bodies is, that the gelatinous matter of which they conſiſt is tranſparent. It is not improbable the ſame phænomena would be as obvious in the bodies of other creatures, and of even human beings, if the opacity of the materials of which we conſiſt did not hinder the light within us from ſhining ſo as to be ſeen.

The remarks hitherto made chiefly refer to the larger ſpecies of light-emitting creatures. The ſame apply, as far as I can judge, to all the ſmaller ſpecies. A veſſel of the water, containing no viſible animalcula, was carried, the ſame evening, to my chamber. When agitated from without, it ſparkled; and if ſtirred by the finger within, the number of ſhining ſpots increaſed. When left to reſt, lucid points were frequently to be ſeen arranging themſelves at the ſurface of the water, where it touched the inſide of the glaſs. Some of this water, that was poured upon the table, appeared full of ſhining points, like ſparks of fire. There was not a doubt in my mind, that theſe phænomena, like the others, were animalcular; yet, on viewing the water in the morning, it was as tranſparent as ſea water uſually is, and not a ſingle creature was to be diſcerned in it. The preſumption, therefore, is, that this form of marine light is alſo owing to animalcules, though too ſmall to be diſcerned by the eye unaſſiſted by optical glaſſes. I am ſomewhat doubtful whether the tranſparency of theſe minute light-emitting creatures would allow them to be diſtinguiſhed if I had had a microſcope with me.

Reaſoning in this manner, I became perſuaded that the luminous appearance of ocean water in other caſes, wherein no flaſh or ſparkle was diſtinctly to be ſeen, or traced to an individual point, but an indiſtinct glow alone appeared, as around the blades of ores, or near the bows and rudders of veſſels in motion, that the phænomenon was, in like manner, referable to animalcular action. And I terminated my ſpeculation by concluding, that the light emitted from millions of theſe viewleſs aquatic animals concurred to produce the general luminous appearance of the ocean in which they float, by the ſame rule that innumerable cluſters of fixed ſtars, as modern aſtronomers teach us, produce the luminous ſpots or milky hue of thoſe portions of the heavens where Omnipotence has placed them.

I have ſaid nothing about the manner in which the light is evolved in theſe animals. If it is by the decompoſition of oxygenous air that light is ſo freely emitted, what becomes of the caloric? for their bodies are not ſenſibly heated, nor

warmer than the fluid in which they ſwim. Still it is not to be denied, that in the decompoſition of that triple fluid there may be an evolution of caloric ſufficient for the œconomy of creatures ſo ſmall, and of a ſtructure ſo nice and exquiſite as theſe, and yet not be meaſurable by our thermometers; and that oxygen may mingle with their fluids in due quantity. And it may be eaſily conceived, that during the proceſs light may be evolved, ſufficient, in rapidity and quantity within them, to occaſion, by tranſmiſſion through their pellucid forms, the phænomena of theſe and all other luminous oceanic meteors.

The animalcular origin of this phænomena is corroborated by this additional conſideration. At the time when the ſalt water is remarkably luminous in ſome places, there is very little of it to be ſeen in others, though but a few rods diſtant. At ſuch times, I found that by taking up parcels of the water, and viewing it, there were abundance of lucid points in thoſe which were moſt luminous, and but few in thoſe which were feebly ſo. The light proceeding from theſe inviſible *inteſtinas*, when nearly and narrowly examined, radiates from numberleſs ſhining particles or centres; and, when viewed from a diſtance too remote to permit theſe lucid centres to be ſeen, the effect produced on the organ of viſion is a general and weaker impreſſion, as if every drop of water was luminous, by reaſon of ſomething chemically diſſolved in it.

The ſame creatures are not capable of emitting light for a long continuance of time. If ſhaken, touched, or agitated, their luminous faculty ſoon becomes exhauſted, and the water in which they float immediately returns to its ordinary colour. This is ſo much the caſe, that if a very luminous portion of water (I do not mean a current) be much moved by the limbs of ſeveral perſons ſwimming or wading in it, its luminous quality will in a few minutes be ſenſibly diminiſhed. Therefore, when a boat is rowed along, or a ſhip is moved by the wind, or when a ſtream ruſhes over rocks, or againſt any kind of obſtacle, the light emitted in ſuch inſtances is produced by a ſucceſſion of animals, each of which, on being ſtimulated, evolves, in its turn, a certain proportion and duration of light, and in this manner gives continuance or permanency to the phænomenon.

In October 1772, Mr. Forſter obſerved the ſouthern ocean, beyond the Cape of Good Hope, illuminated in a ſimilar manner. (Voyage round the World by Cook and Forſter, vol. iii. p. 45.) The curious inquirer will be ſtruck with the correſpondence of the phænomena off Table-Bay, and thoſe in Long-Iſland Sound. The circumnavigator aſcribed the luminous

luminous appearance of the ſea water, in 34 degrees ſouth latitude, to animals of the ſame genus which cauſed it in 40° 40 north. He ſaw the ocean luminous in 58° ſouth, during March 1773, while the weather was tempeſtuous, and ſo cold that the quickſilver in the thermometer was as low as $33\frac{1}{4}$° at noon. Thus it appears theſe creatures can live in water of any temperature above the freezing point. (*Ib.* p. 97.)

An opinion has been entertained, that, during the ſhining of the ſun, its rays are abſorbed by the ocean, and that the extrication of them again makes its water luminous. It has been conjectured, too, that the water of the ocean becomes occaſionally ſo highly electrical, that the brightneſs it manifeſts is but the evidence of a high charge of electricity. There has been publiſhed, too, an idea that the phoſphoric matter extricated from putrefying fiſh in the ocean, was the cauſe of this marine reſplendence. And others have even been inclined to think that the light proceeded from ſome attrition of ſaline particles againſt each other, or ſome unknown combinations formed among them. The true cauſe of the phænomenon, I am inclined to conclude, is neither of theſe, but univerſally, as far as my knowledge of the ſubject extends, is a function of animals. Theſe are often conſpicuous in tempeſts, when

> High o'er the poop the audacious ſeas aſpire,
> Uproll'd in hills of fluctuating fire. FALCONER.

And though the timid may be impreſſed with additional alarm at this appearance,

> Not ſo the man of philoſophic eye
> And inſpect ſage; the waving brightneſs he
> Curious ſurveys, inquiſitive to know
> The cauſes and materials, yet unfix'd,
> Of this appearance beautiful—— THOMSON.

It is remarkable how far theſe creatures, on ſome occaſions, are carried up our rivers. During the drought of the year 1796, when ſea crabs were plentifully caught in the Hudſon as high as Poughkeepſie (eighty miles from New-York), the water of the river was luminous in the neighbourhood of Pollepell's iſland, as I ſailed through the Highlands one dark night.

I forbear to trace the analogies between theſe aquatic animals and the numerous aërial ſpecies which emit light. Leaving theſe to your ſagacity and penetration, I have only to conclude by renewing the aſſurances of my reſpect.

SAMUEL L. MITCHILL.

Cedar-Grove, Oct. 1, 1809.

IV. *Re-*

IV. *Researches on Alumine. Read Dec.* 18, 1800, *in the Society of Physics and Natural History at Geneva. By* THEODORE DE SAUSSURE.

On the Combination of Alumine with the Carbonic Acid.

I. ONE cannot help being astonished that, though most of the combinations of alumine with the acids are known, we have still but imperfect notions respecting the union of this earth with a substance so widely diffused as the carbonic acid. When desirous of repeating the experiments of M. Humboldt on the absorption of oxygen gas by simple earths, I was induced to consider alumine in its different states, and particularly in that in which most chemists consider it as a carbonat. On this subject I have made some observations, which may serve to throw new light on this combination.

Opinions of some Chemists respecting the Carbonats of Alumine.

II. Bergman, in a dissertation on the aërian acid, says *: "Fixed air attacks pure argil with difficulty, that is to say, the earth of alum dried and hardened; the precipitation of alum, however, by aërated alkali, proves that it may take up a small quantity when it is attenuated; for though the liquor, when well filtered, appears limpid, it is remarked that, when left a few days to the open air, and a heat capable of promoting the extrication of the fixed air, it becomes turbid, and insensibly deposits a little earth, which was held in solution by the volatile fluid. The argil of Cologne itself gives, in a strong heat, a quantity of fixed air which exceeds its volume several times. It is mixed with a little inflammable air, which rises at the commencement of the operation."

Bergman then gives the proportions of the carbonic acid in artificial carbonat of alumine, and finds, that 100 parts of aërian acid may unite with 30 of pure alumine.

III. Fourcroy, in his Elements of Chemistry, and his work entitled *Système des Connoissances Chimiques* †, admits also the combination of alumine with carbonic acid gas under the denomination of carbonat: 1st, According to the experiments of Bergman; 2d, According to his own. He observed that, if the precipitation of the sulphat of alumine by an alkaline carbonat be made cold, little or no effervescence is produced, because, in his opinion, a part of the carbonic

* French edition of his works, Vol. I. † Vol. IV. p. 61.

acid

acid gas which is separated from the alkali joins the precipitated alumine and the other part the liquor, which then holds in solution real carbonat of alumine, which may be obtained by volatilising the acid gas. He then says, that natural aluminous earths are very frequently found combined with carbonic acid, which may be separated by a stronger acid.

Gren announces *, that alumine has no affinity for carbonic acid. This author enters into no detail on this subject, and he seems to support his opinion on the effervescence produced during the decomposition of the sulphat of alumine by the alkaline carbonats.

C. Hassenfratz has since that time given the specific gravities of alumine and the carbonat of alumine. Several other authors have admitted, and still admit, aluminous carbonats, both artificial and natural.

IV. I shall now give the result of my researches on this combination. I dissolved sulphat of alumine, known under the name of Roman alum †, in water, and precipitated it from the liquor cold by a saturated solution of the carbonat of potash. Little or no effervescence was produced, as was observed by Fourcroy (III). This effect, however, does not take place but when the solution is diluted with a certain quantity of water. The alumine obtained by this operation, after having been washed several times while still moist, and dried at the temperature of the atmosphere, was equal in weight to the twenty-nine hundredths of the sulphat of alumine employed: it dissolved in nitric acid with a strong effervescence, and lost about seven hundredths of its weight of carbonic acid gas. The precipitation of the sulphat of alumine by the carbonat of soda exhibited results nearly similar. I shall here add,

* Manuel de Chimie, § 449 and 516.

† For these experiments I made choice of a sulphat of alumine which contained but a very small quantity of the oxyd of iron, and I ascertained, by comparative experiments on alumine, as pure as it possibly could be, that this small dose of oxyd had no sensible influence on the results which I am about to give. The iron in the common sulphat of alumine is at its minimum of oxydation. None of it was precipitated by the alkaline prussiats till after the mixture had been exposed to the free air and the heat; and it may be easily proved that, if alumine extracted from alum was employed in the repetition of Humboldt's experiments, it was by the presence of the oxyd of iron that several chemists have been led into an error respecting the absorption of the oxygen gas of the atmosphere by an earth supposed to be pure, and which was not so. For alumine, purified by repeated solutions in potash, never, when moistened, exercised any other action on the oxygen gas of the atmosphere in the experiments I made on this subject. Common alum, sufficiently pure for the alumine extracted from it to give the same results in its purifications, may be often found.

that

that the quantity of the carbonic acid gas disengaged was not constant in the different operations, and that it appeared to me to vary in the ratio of the concentration of the alkaline carbonats, and in particular of the superabundant quantity which I added of these carbonats to decompose the sulphats. The precipitates in all these cases were washed in such a manner as to avoid every error in this ratio.

V. A hundred parts of the same sulphat of alumine, precipitated by carbonat of ammonia in excess, furnished only 23 parts of alumine dried at the temperature of the atmosphere. The earth dissolved in acids with a disengagement of carbonic acid gas, but it lost in aërian acid only *one and a half per cent.* during the operation.

Berthollet, in his ingenious researches on affinities, found that alumine precipitated by ammonia from potashed sulphat of alumine still retained potash and acid. To purify this earth, I dissolved it in muriatic acid, and precipitated it again by carbonat of ammonia. The 23 parts of alumine were, by this purification, reduced to 21 parts. They lost then one and a half *per cent.* of carbonic acid gas by their solution in the acids. They could not form octaëdral crystals with sulphuric acid; and the imponderable quantity of muriatic acid which they retained could not produce any sensible error. In the following experiments I shall give the name of *pure alumine* to the earth obtained from alum subjected to this double precipitation.

I divided the pure alumine into two parts, one of which was pulverised, and the other left in its natural state of aggregation. They were exposed to the open air for eighteen months on a tablet in my laboratory, after which period the pulverised alumine produced no effervescence*. The alumine which had not been pulverised, and which was placed in the same circumstances, produced a very sensible one. This phænomenon inclined me to think that the effervescence of the alumine, which I believed to be in the state of carbonat, arose from the carbonat of ammonia retained in the unpulverised alumine, and which had been volatilised in the other, all the parts of which prevented free access to the external air. I, indeed, found that potash triturated with the effervescent alumine, disengaged it from ammonia, and did not produce the same effect on the same earth when pulverised.

* This fact is contrary to that announced by Fourcroy. (*Système des Connoissances Chimiques*, tom. ii. p. 145.) He says alumine gradually takes up the carbonic acid gas of the atmosphere. It would be of importance to know the details of th s observation, which, in my opinion, was never made but by the author here quoted.

VI. I

VI. I precipitated by liquid ammonia a solution of pure alumine, and obtained, after the precipitate had been dried, a quantity of spongy alumine, equal in weight to that which I had obtained from the same quantity of a solution of alumine when I decomposed it by carbonat of ammonia, and when I did not add an excess of precipitant. A hundred parts of potashed sulphat of alumine, entirely decomposed by ammonia or the carbonat of ammonia, furnished 21 parts of spongy alumine dried in a temperature of between 72 and 85 degrees of Fahrenheit's thermometer. These 21 parts were reduced to 9, by desiccation, in a violent fusing heat. A hundred parts of the alum which I employed, contained, then, no more than about nine parts of pure dried alumine: a proportion very different from that which some authors have ascribed to the composition of this salt.

VII. I dissolved alumine to saturation in nitric acid diluted with water, and placed in this solution a rhomboidal crystal of carbonat of lime. A slow effervescence was produced, which even continued for several weeks. The alumine deposited by this operation produced no effervescence with acids. On this occasion it appeared to be doubtful whether calcareous earth alone be a medium proper for uniting alumine with carbonic acid; and, if I thought there was reason to ascribe to this cause the great quantity of carbonic acid which I found in the dolomies, it was because I was deceived by the extraordinary quantity of alumine contained in some specimens which I analysed. Mr. Tennant had more reason to ascribe the properties of the dolomies to the triple combination of the carbonic acid with the calcareous earth and the magnesia, which the dolomies always contain in a large quantity, while the purest contain only an infinitely small quantity of alumine. It appears that the dolomie is to the *bitter-spath* of the Germans what marble is to calcareous spar.

I subjected to distillation alumine precipitated from its sulphat by carbonat of ammonia, and dried at the temperature of the atmosphere. I obtained from this operation, after a long and strong incandescence, only water, but no carbonic acid gas.

VIII. I thought I should be able to explain the experiment of Fourcroy, which proves the pure and simple combination of alumine with carbonic acid, because it is not disengaged with effervescence during the decomposition of aluminous solutions by alkaline carbonats, by ascribing its result, in part, to the triple and concrete formation of an aluminous combination of carbonic acid and alkali; but I abandoned that opinion by observing that, when a solution of alumine is decomposed

compoſed only in part by carbonat of ſoda and potaſh, an alumine is obtained, which makes no ſenſible effervescence with acids, though there was no effervescence during its precipitation. I then thought that the water of the ſolution, which muſt be a little diluted to produce no effervescence, might be alone ſufficient to retain the carbonic acid. But this quantity of water, compared with the volume of the carbonic acid which ought to reſult from the decompoſition of the alkaline carbonat, could retain by its own affinity for the carbonic acid only a very ſmall part of that which remained in the ſolution. May we not here ſuppoſe, agreeably to the ideas of Berthollet reſpecting affinities, that the alumine precipitated contributes by its maſs, conjointly with the acidiferous ſolution and the alkali, to retain the carbonic acid? We ſhall find hereafter that the carbonated water diſſolves alumine. But this ſolution, when filtered, ſeems alſo to abandon its carbonic acid in the open air as eaſily as pure carbonated water.

IX. I have already mentioned (II.) what Bergman ſtates, that when a ſolution of alumine is precipitated by alkaline carbonats, there is formed in the liquor, when it has been expoſed ſeveral days to the free air and heat, an earthy depoſit, ariſing from the expulſion of the carbonic acid which held it in ſolution. I repeated this experiment with all the alkalies ſaturated with carbonic acid, but I never could obſerve any precipitation poſterior to that of the alumine by the alkaline carbonat; and I think it probable that the reſult Bergman obtained was becauſe his alumine was not pure, or becauſe his alkalies, being imperfectly ſaturated with carbonic acid, had diſſolved a ſmall quantity of earth. Beſides, the precipitate I ought to have obtained would have been a combination of alumine and alkaline carbonat.

Being deſirous to aſcertain, by a more direct experiment than the preceding, if carbonated water was capable of diſſolving alumine, I put into two-necked bottles pure alumine recently precipitated by carbonat of ammonia, and ſtill moiſt. I diluted it with a great quantity of diſtilled water: I cauſed to circulate for eight hours, into this mixture, a current of carbonic acid gas. This water, when filtered, was ſubjected to ebullition: it immediately became turbid and depoſited alumine, which potaſh was able to diſſolve. The carbonated water of alumine became turbid alſo on being mixed with ſome drops of ammonia; and, at laſt, by the mere agitation of the corked bottle, in which it was, when only half full.

I collected two or three grains of the alumine, precipitated from the carbonated water by means of its expoſure to the air:

it

it produced no efferveſcence by diſſolving in acids, even when I made the proof, before it was completely dried at the temperature of the atmoſphere. The caſe is the ſame with the alumine depoſited at the bottom of bottles in which the carbonic acid gas had circulated.

X. Bergman, then, had reaſon to announce that alumine, carbonic acid, and water, can enter into combination, though the experiments on which he founded his aſſertion do not appear to me proper for proving it; but he ought not to have admitted, that alumine with carbonic acid formed a concrete carbonate.

On the other hand, Gren had ſome reaſon for ſaying that alumine, precipitated from its ſolutions by alkaline carbonates, did not preſent itſelf in the form of carbonate of alumine. But he ought not to have inferred that alumine has no affinity for carbonic acid, ſince we have ſeen that carbonated water diſſolves that earth. Under theſe two points of view, both theſe chemiſts ſeem to have been deceived, though with oppoſite ſentiments, as too often happens when a particular truth is given out as a general truth.

Of Native Carbonates of Alumine.

XI. Hitherto I have examined only thoſe aluminous carbonates conſidered as the production of art. It now remains for me to ſpeak of thoſe which are conſidered as natural. I ſhall not examine whether the carbonic acid forms compound or ternary combinations with alumine and another earth or a metallic oxide. There is no need to ſay, that becauſe theſe combinations exiſt, we ought to conclude that the carbonic acid forms with alumine a concrete carbonate. Bergman infers that the latter compound exiſts in nature, becauſe the argil of Cologne, expoſed to a ſtrong heat, gave him ſeveral times its volume of carbonic acid gas. If we put out of conſideration the ternary or quaternary combinations in which the argil of Cologne may be found, ſince it contains the half or the fourth of its weight of ſubſtances foreign to alumine, the concluſion of Bergman would be juſt, if it were certain that its earth contained no vegetable or animal matter. But as the greater part of the argils found at the ſurface of the earth contain ſome, and as they detonate ſlightly with nitre, little credit can be given to the obſervation of Bergman; eſpecially as he adds, that the carbonic acid gas he obtained was mixed with hydrogen gas, which ſeems to announce here the decompoſition of ſome vegetable or animal matter, or of water preſent with carbon in this argil *.

* See Home's Principles of Agriculture and Vegetation.

There is another earth of the same kind, but much freer from foreign principles. It is denoted in most authors under the name of the pure argil of Hales (*reine thonesde de Werner*), the place where it was found, in the garden of the college of Hales, and in the neighbourhood of an apothecary's shop; its exterior form, its small quantity, and its purity, have made some authors suppose that it was a production of art. This may be, but it merits no less the attention of naturalists, since it has characters which alumine prepared artificially has not. M. Lenz says, the pure argil is found in other places than at the college of Hales; but he does not say whether it be crystallized like that which is here alluded to.

M. Schreber, who analysed this substance, considers it as a combination of alumine with carbonic acid, water, and a little lime, silex, iron, inflammable matter, and, sometimes, gypsum. I have not been able to procure the details of the labour of this naturalist on this earth, but the small quantity (about five grammes or 77 grains) which I had at my disposal was sufficient to persuade me that it contained no carbonic acid. I shall here describe the principal external characters of it, according to the specimens from which I obtained my results. It is as white as snow; its external form is kidney or mushroom; it has a fine earthy fracture, is tender and almost friable; adheres little to the tongue, is somewhat translucid at the edges, and seems fine to the touch, but not fat*.

* Pure spongy or gelatinous alumine is not fat or unctuous, or at least it is not more so than any other earth reduced to the same state of division: it does not even become so by being mixed with water after it has been dried at the temperature of the atmosphere. Under these circumstances it cannot resolve itself with that liquid into a connected paste, more or less viscous, like the greater part of the native clays: alumine is indebted for its unctuosity, which is improperly considered as one of its essential characters, only to its mixture with other substances.

The case is the same with the *earthy odour*, which is considered as essential to moistened alumine, and which, in my opinion, does not belong to this earth, when disengaged from every combination. It is found that this odour decreases in argil in proportion as it is deprived of the oxide of iron. Moistened alumine, obtained from common alum, affects the organs of smell in a manner scarcely sensible; but the earthy odour no longer exists in alumine purified by potash, when it has been again moistened after being dried in the common temperature of the atmosphere. If a delicate smell can distinguish it at the moment of its precipitation, it is because the alumine, after having been dissolved once in potash, retains a small quantity of the oxide of iron; for alumine, purified in one operation by this last process, can furnish by alkaline prussiates, a quantity of prussiate of iron very superior to that which always exists in the purest alkaline prussiates. By means of trituration with oxide of iron, I communicated to inodorous alumine an aluminous or earthy odour. It is possible that this substance may communicate the same odour to other earths. for Vauquelin found that some chalcedonies exhaled an aluminous odour when triturated, though they contained no alumine.

By a microscope of a magnifying power equal to 200 or 300, it appeared, as Schreber has remarked, that it is composed of small transparent prismatic crystals, compressed and terminated by blunted pyramids. I was not able to discover this crystallization in alumine prepared artificially.

At the first degrees of incandescence it loses about two-thirds of its weight. Alumine loses only fifty-eight hundredths.

A decoction of it in water did not change test paper, but it became turbid by the oxalate of potash and solution of barytes. This solution, evaporated to dryness in a gentle heat, left a residuum which was only the 0·022 part of the alumine employed. It was composed of sulphate of lime, and a yellow matter, susceptible of being carbonated by combination, and similar to vegetable extract.

A gramme (15·44 grains) of the argil of Hales, dissolved cold, a hundredth part excepted, in nitric acid, without producing any effervescence. None was produced when the solution was made at a heat equal to 60° of Reaumur (167° Fahr.). The sulphuric acid dissolved it also cold, almost entirely, and without effervescence.

A solution of this earth by the nitric acid was not rendered turbid by muriate of platina.

The same solution was precipitated, cold, by carbonate of ammonia in excess. The liquor, when filtered, was exposed to ebullition, to try whether it contained glucina. By this operation it became pretty turbid; the new substance was carefully collected, and weighed, when dried at the temperature of the atmosphere, about seven-hundredths of the native argil: but I doubt whether it was glucina; for it produced no effervescence when dissolving in nitric acid, as glucina would have done in the like case, according to the experiments of Vauquelin. A solution of it in nitric acid in excess was not precipitated by prussiate of potash, oxalate of potash, and sulphuric acid; but it was by ammonia. This precipitate was soluble in potash; it was therefore not gadolinite. Was it a new substance, or alumine united to a base, which gave it the property of dissolving in carbonate of ammonia? Those who possess argil of Hales in sufficient quantity may be able to determine this question.

Potash was able to dissolve, an imponderable quantity of the oxide of iron excepted, the alumine precipitated from the nitric acid by the carbonate of ammonia in the preceding operation. This alumine, separated from potash, crystallized in octaedra with the alkaline addition requisite in such a case.

The argil of Hales, projected into nitre in fusion, produced no detonation; it showed only in obscurity a very faint blue

trace, which undulated at the surface of the salt. But this effect is doubtful: when projected on ignited iron, it retained a light scarcely sensible.

In the last place, I subjected to distillation, at a red heat, in a luted glass retort, one gramme and a half (23·16 grains) of this substance. I obtained some drops of a liquid transparent as water, and a quantity of air which did not exceed the capacity of the vessels used for distilling. This air contained one or two hundredths of carbonic acid gas; a quantity inferior to what I expected to obtain by the decomposition of water and the inflammable matter contained in the clay. The carbonic acid gas, naturally belonging to the air of the vessels anterior to the distillation, must be deducted from the estimation I have given.

XII. I shall recapitulate, in a few words, the principal results of these observations:

1st, Alumine does not form with carbonic acid a concrete carbonate of alumine; or, at least, no one has been able to form that combination.

2d, The substance, hitherto considered as artificial concrete carbonate of alumine, is the result of the union of alumine with alkali and carbonic acid. This acid does not, probably, enter into this combination but by its affinity for the alkali.

3d, Alumine does not seem to unite with carbonic acid but in the case when the latter is dissolved in water; when this earth precipitates itself from this solution by the volatilization of the carbonic acid, it does not appear in the state of carbonate.

4th, Native clays, considered by some authors as carbonates of alumine, did not appear to me to be in that state.

5th, The native argil of Hales, precipitated from its solutions in nitric acid by carbonate of ammonia in excess, leaves in solution in the latter salt, a substance or combination which deserves further examination.

[To be continued.]

V. *Description of a Horse without Hair.* By C. De Lasteyrie, *Member of the Philomatic Society* *.

THE first men who observed nature, struck with the wonders which it continually presented to their minds, fell into the marvellous, because they were as yet unacquainted with its laws, its means, and its powers. Such is the origin

* From the *Journal de Physique*, Floreal, an. 9.

of

of thoſe ridiculous tales and abſurd ſuppoſitions to be found in antient authors, and which have been tranſmitted, from age to age, till the period when mankind began to examine with more accuracy, and to make better obſervations.

By multiplying reſearches they have been rendered more exact: at preſent there is no neceſſity for believing a fact merely becauſe it contains ſomething of the marvellous, or is mentioned by ſuch or ſuch an author.

Is the horſe without hair, which forms the ſubject of this article, to be conſidered as a new variety in the ſpecies, or are the characters by which this ſeems to be indicated a mere accident, produced by diſeaſe, or the effect of art? The proofs I have obtained, and the obſervations I have made on this animal, incline me to believe that it is an individual of a peculiar variety. "Inſtead of contracting the limits of its power," ſays Buffon, ſpeaking of nature, "we muſt enlarge and extend them even to immenſity; we muſt ſee nothing impoſſible, we muſt ſuppoſe every thing, and believe that every thing which can be really exiſts!" Though the number, indeed, of the travellers who give themſelves the trouble to make obſervations is very inconſiderable, we however are daily made acquainted with new facts, and we ſee nature extended in proportion as we give extenſion to our reſearches. By comparing the countries, the productions of which are known with thoſe which have not yet been examined by naturaliſts, it may be eaſily perceived that the field which remains for us to be paſſed over is of greater extent than that paſſed over by our predeceſſors. If the number of the ſubſtances contained in the bowels of the earth, and that of the beings which elude our reſearches at its ſurface, is prodigious, may we not alſo believe that there exiſt ſubſtances and beings more eaſily to be diſcovered, of which, however, we have as yet no accounts?

I ſhall now relate the hiſtory of the horſe without hair and mane, ſuch as I received it.—He was purchaſed, about ten years ago, at Vienna, by a Frenchman named Alpi, formerly employed in the menagerie of Verſailles, by whom he was exhibited in ſeveral towns of Germany with other animals, and afterwards ſold, for fifty louis, to the Veterinary School at Berlin. This horſe had been taken from the Turks during the laſt war, and carried by an Auſtrian officer to Vienna. Alpi exhibited him under the name of the Horſe of the Nile, and ſaid he came from Africa. He yoked him to a cart on which he carried about his animals. Four years ago he was in the Veterinary College of Berlin.

This horſe appears to me to be about twenty years of age;

he eats the same food, and in the same quantity, as common horses: he is meagre, as he always had been from the time he was brought to the Veterinary School. He is strong and vigorous, trots somewhat hard on account of his age, and because he has been employed in the draught. He is very sensible to cold, and therefore during winter is always kept exceedingly warm. His head is small and well made, the neck pretty, and the chest open; his legs, on which he stands well, are slender; but the rest of his body is not so beautiful, on account of his age and meagre state.

He differs from other horses only in the want of hair, the depression of his forehead, and the noise he makes when breathing. I have carefully observed all the parts of his body, even the interior of the ears, and I have found only a black bristle, about three-tenths of an inch in length, on the lower eye-lid of the left eye. His skin is of a black colour inclining to gray, with some white spots on the flanks and groin. It is plaited on the upper part of the chest, is very soft to the touch on the whole body, and has a shining and unctuous appearance. What gives reason to believe that the want of hair in this animal is neither the effect of art nor the result of disease is, that the skin on the nose, around the nostrils, and on the upper and lower lips, differs from that of other horses, and has all the characters above indicated: it has almost all the appearances of that of the Turkish dog. A very distinguishing character is the depression in the middle of the forehead, measuring from the anterior angle of the eyes and the angle of the mouth. This depression, which contracts the aperture formed by the nasal bone, occasions some embarrassment to the animal in breathing, and at each inspiration and expiration it makes a noise which may be compared to that made by a person when the nostrils are obstructed. This noise increases when the animal has been running, or employed in hard labour. He has, however, strong lungs and good wind.

VI. *Description of a newly invented Galvanometer, and an Account of some Experiments made with Volta's Pile upon several of the Gases.* *By* W. H. Pepys *jun. Esq.**

During a course of experiments upon atmospheric electricity, with which I occupied myself in the year 1798, I

* Communicated by the author.

had

had frequently occasion to make use of the gold-leaf electrometer invented by Mr. Bennet.

I had often been wishing that some instrument could be devised to measure the galvanic action of a plate of silver and one of zinc, when connected with the tongue and upper lip; and as some philosophers had all along maintained that the galvanic and electric fluid were the same, the delicate sensibility of the gold-leaf electrometer suggested the idea of accommodating it to the object I had in view, for which purpose I adopted the following construction:

Fig. 1. (Plate I.) represents the galvanometer complete, the top or lid, to facilitate the description, being shown above the glass cylinder instead of being inserted in its mouth, as it is when the instrument is in use. The top consists of two circular plates of brass fastened to each other, and attached to a cork which fits into the cylinder. The undermost plate has an oblong hole cut though it (as has also the cork), and from this hole a groove passes to the outer edge of the plate to admit a thin slip of silver AA, and allow it to slide backwards or forwards between the plates, for the purpose of moving the gold leaves *a*, attached to the silver, nearer to or further from the upright pieces B and C. This part of the construction is also shown in fig. 2. which represents the metallic part of the cover inverted, AA being the slip of silver. One end of the silver, viz. that which descends into the cylinder (fig. 1.), is slit, for the purpose of receiving the gold leaves.

BB, CC, are two pieces of zinc, the uprights of which can be made to approach to or recede from each other by means of a slide in the transverse pieces at the bottom of the jar, and which is represented in fig. 3. The two pieces of zinc are kept at the distance desired by means of the screw D, fig. 1 and 3.

The zinc BB, properly speaking, is of two pieces, attached by a joint at E to facilitate the arrangement when the instrument is intended to be put in action.

The bottom-part *m*, which receives the glass cylinder, is of box-wood, and is furnished with glass feet, FFF, for the purpose of occasional insulation.

The instrument being fitted up to my liking, I tried its effect by introducing the exterior end of the slip of silver between my upper lip and gum, and laying the moveable piece of zinc upon my tongue. The distance of the two pieces of zinc was 1-4th of an inch. I could not perceive the smallest effect to take place. I tried it with the zinc pieces 1-8th of an inch asunder, and also at the distance of 1-16th, but still

without obſerving any divergence of the gold leaves or any peculiar taſte.

When the gold came into abſolute contact with the zinc the taſte was inſtantly perceptible, in the ſame manner as when an immediate connection is eſtabliſhed between zinc and ſilver, by bringing them into contact between the teeth after they have been properly diſpoſed in the mouth; but I could never perceive, when they were ſenſibly aſunder, the ſmalleſt effect, and therefore, after repeated fruitleſs attempts to increaſe the action by enlarging the ſurfaces of the metals in contact with the mouth, laid the inſtrument aſide, as uſeleſs, except as a more delicate electrometer.

As I attributed my want of ſucceſs not ſo much to any error either in the principle or conſtruction of my inſtrument, as to the ſmallneſs of the galvanic charge, M. Volta had no ſooner made his pile known, than it occurred to me, that, as a ſtronger charge might now be obtained, the inſtrument I had conſtructed would certainly be affected by it, *if the electric and galvanic fluid poſſeſſed identity*.

My friend, Mr. Henry Lawſon, having conſtructed a pile, conſiſting of 80 pieces of zinc, and as many of ſilver, we made the experiment together. The ſilver of the galvanometer was connected with the upper piece of the pile, which was zinc, while the ſilver end of the pile was in contact with the zinc of the galvanometer. The ſliding pieces BC were then adjuſted, and, at the diſtance of 1-3d of an inch from each other, the gold leaves diverged: upon preſenting excited glaſs they opened ſtill further, proving it to be that ſtate called plus, or poſitive.

We then reverſed the connection, making the lower or zinc end of the galvanometer join the upper or zinc end of the pile, and the ſilver ſlip join the lower or ſilver end of the pile. In this caſe, excited glaſs made the leaves to cloſe, while excited ſealing-wax opened them further.

When we made this trial of the galvanometer, the pile was giving ſhocks, that were taken with a ſenſation equal to what would have been experienced from a charge of as much coated ſurface of electricity as would, if diſcharged through the galvanometer, have torn and deſtroyed the gold leaves, while by galvaniſm they were only diverged equal to about 1-4th of an inch: even ſealing-wax ſlightly excited, preſented to the inſtrument, kept the leaves in conſtant motion.

Since that time I have performed a number of experiments with Volta's pile; indeed, I have repeated almoſt all the experiments with it which have yet been made public, beſides

making

making several a little different from any I have yet heard of, and in all of them I have found the galvanometer so useful an instrument, that I can recommend it with some confidence to those who are fond of such experiments.

I shall not encroach upon the pages of the Philosophical Magazine by detailing the results of experiments in which others have anticipated me; but shall, as briefly as possible, state a few experiments respecting the action of the galvanic pile on several of the gases, which present some new facts on this interesting subject.

In these experiments an exhausted transfer was screwed upon the top of a graduated glass cylinder, open at the bottom. The cylinder being filled with water and placed over a pneumatic tub, was then charged with gas to any particular division, and the division noted, by which means the quantity allowed to ascend into the transfer, upon opening a cock interposed between it and the cylinder, was known; and consequently, whether any or what quantity of the gas under experiment was absorbed by the process.

I. The pile being placed, with a small tube containing distilled water, and connecting wires of fine silver, in the exhausted transfer, the quantity of atmospheric air admitted from the adjoining graduated cylinder was registered. After standing in this way for 36 hours, out of 200 cubic inches of atmospheric air, 40 were found to have been absorbed. During the whole time of the absorption, gas was formed in the small tube of water, and a floculent oxyd was precipitated.

II. When oxygen gas, obtained from the oxymuriat of potash, was used, the power of the pile was considerably increased; the one wire gave out gas more rapidly, while a much more copious floculent precipitate was formed by the other. Leaving this experiment during the night, 200 cubic inches of oxygen were found to have been absorbed by the morning. Water had ascended from the pneumatic tub, and not only filled the graduated cylinder, but risen so high into the transfer, that the pile was half immersed in it. The exhaustion, thus produced, maintained a column of water of about 16 inches in height.

III. Azotic gas, procured by the decomposition of atmospheric air by the sulphuret of potash, totally stopped the action of the pile, neither gas nor precipitate appearing in the small tube of water.

IV. With hydrogen gas the effect was the same. I could not perceive that the pile had the smallest action.

It is proper that I should observe here, that the cloths interposed between each pair of metals in these experiments were

were moiſtened with a ſolution of common ſalt. If the cloths be ſoaked in acids, the reſult, as every one knows, will be very different; the pile will then act as powerfully even in *vacuo* as in atmoſpheric air.

An anonymous correſpondent, in the laſt number of the Philoſophical Magazine, notices the increaſed action of the pile by acids; but becauſe he finds that the alkalies, particularly pure ammonia, alſo increaſe its action moſt powerfully, infers, that the fluid excited in the pile does not ariſe from the action of acids, or from *any combination of oxygen with the metals*. Before making ſuch an inference, he ought to have tried his pile in ſuch circumſtances as would have precluded the poſſibility of oxygen having acceſs to it. In vacuo his pile would have ſpeedily ceaſed to act, even with ſolutions of alkali interpoſed between the pairs of plates. He ought alſo to have examined the ſtate of the reſidual water in the two glaſſes, connected by means of a ſyphon, before he proceeded to overturn the Lavoiſierian ſyſtem from the circumſtance of oxygen gas being produced in the one glaſs and hydrogen gas in the other.

The laſt paragraph in his paper is equally inconcluſive, where he would infer, becauſe an electrometer gives ſigns of negative electricity when a drop of water is let fall upon a piece of red-hot iron placed upon it, that therefore poſitive electricity and water form hydrogen air. The preſence of hydrogen is not neceſſary to the electrometer indicating negative electricity; if the water be converted into vapour, the effect is produced: indeed, the vapour of any kind of liquid produces the negative ſtate.

VII. *Obſervations on the Means of increaſing the Quantities of Heat obtained in the Combuſtion of Fuel. By Count* RUMFORD *.

IT is a fact which has been long known, that clays, and ſeveral other incombuſtible ſubſtances, when mixed with ſea-coal, in certain proportions, cauſe the coal to give out more heat in its combuſtion than it can be made to produce when it is burnt pure or unmixed; but the cauſe of this increaſe of heat does not appear to have been yet inveſtigated with that attention which ſo extraordinary and important a circumſtance ſeems to demand.

Daily experience teaches us, that all bodies—thoſe which

* From the *Journals of the Royal Inſtitution of Great Britain.*

are

are incombuſtible, as well as thoſe which are combuſtible, and actually burning,—throw off, in all directions, heat, or rather calorific (heat-making) rays, which generate heat wherever they are ſtopped or abſorbed: but common obſervation was hardly ſufficient to ſhow any perceptible difference between the quantities of calorific rays thrown off by different bodies, when heated to the ſame temperature, or expoſed in the ſame fire; although the quantities ſo thrown off might be, and probably are, very different.

It has lately been aſcertained, that when the ſides and back of an open chimney fire-place, in which coals are burned, are compoſed of fire-bricks, and heated red-hot, they throw off into the room incomparably more heat than all the coals that could poſſibly be put into the grate, even ſuppoſing them to burn with the greateſt poſſible degree of brightneſs. Hence it appears that a red-hot burning coal does not ſend off near ſo many calorific rays as a piece of red-hot brick or ſtone, of the ſame form and dimenſions; and this intereſting diſcovery will enable us to make very important improvements in the conſtruction of our fire-places, and alſo in the management of our fires.

The fuel, inſtead of being employed to heat the room directly, or by the direct rays from the fire, ſhould be ſo diſpoſed or placed as to heat the back and ſides of the grate; which muſt always be conſtructed of fire-brick or fire-ſtone, and never of iron or of any other metal. Few coals, therefore, when properly placed, make a much better fire than a larger quantity; and ſhallow grates, when they are conſtructed of proper materials, throw more heat into a room, and with a much leſs conſumption of fuel, than deep grates; for a large maſs of coals in the grate arreſts the rays which proceed from the back and ſides of the grate, and prevents their coming into the room; or, as fires are generally managed, it prevents the back and ſides of the grate from ever being ſufficiently heated to aſſiſt much in heating the room, even though they be conſtructed of good materials, and large quantities of coals be conſumed in them.

It is poſſible, however, by a ſimple contrivance, to make a good and an œconomical fire in almoſt any grate, though it would always be adviſable to conſtruct fire-places on good principles, or to improve them by judicious alterations, rather than to depend on the uſe of additional inventions for correcting their defects.

To make a good fire in a bad grate, the bottom of the grate muſt be firſt covered with a ſingle layer of balls, made of good fire-bricks or artificial fire-ſtone, well burnt, each ball

ball being perfectly globular, and about $2\frac{1}{2}$ or $2\frac{3}{4}$ inches in diameter. On this layer of balls the fire is to be kindled, and, in filling the grate, more balls are to be added with the coals that are laid on; care muſt, however, be taken in this operation to mix the coals and the balls well together, otherwiſe, if a number of the balls ſhould get together in a heap, they will cool, not being kept red-hot by the combuſtion of the ſurrounding fuel, and the fire will appear dull in that part; but if no more than a due proportion of the balls are uſed, and if they are properly mixed with the coals, they will all, except it be thoſe perhaps at the bottom of the grate, become red-hot, and the fire will not only be very beautiful, but it will ſend off a vaſt quantity of radiant heat into the room, and will continue to give out heat for a great length of time. It is the opinion of ſeveral perſons who have for a conſiderable time practiſed this method of making their fires, that more than one-third of the fuel uſually conſumed may be ſaved by this ſimple contrivance. It is very probable that, with careful and judicious management, the ſaving would amount to one-half, or fifty per cent.

As theſe balls, made in moulds, and burnt in a kiln, would coſt very little, and as a ſet of them would laſt a long time, probably ſeveral years, the ſaving of expenſe in heating rooms by chimney fires with bad grates, in this way, is obvious; but ſtill it ſhould be remembered, that a ſaving quite as great may be made by altering the grate, and making it a good fire-place.

In uſing theſe balls, care muſt be taken to prevent their accumulating at the bottom of the grate. As the coals go on to conſume, the balls mixed with them will naturally ſettle down towards the bottom of the grate, and the tongs muſt be uſed occaſionally to lift them up; and, as the fire grows low, it will be proper to remove a part of them, and not to replace them in the grate till more coals are introduced. A little experience will ſhow how a fire made in this manner can be managed to the greateſt advantage, and with the leaſt trouble.

Balls made of pieces of any kind of well-burnt hard brick, though not equally durable with fire-brick, will anſwer very well, provided they be made perfectly round; but if they are not quite globular their flat ſides will get together, and by obſtructing the free paſſage of the air amongſt them, and amongſt the coals, will prevent the fire from burning clear and bright.

The beſt compoſition for making theſe balls, when they are formed in moulds, and afterwards dried and burnt in a kiln,

kiln, is pounded crucibles mixed up with moiſtened Sturbridge clay; but good balls may be made with any very hard burnt common bricks, reduced to a coarſe powder, and mixed with Sturbridge clay, or even with common clay. The balls ſhould always be made ſo large as not to paſs through between the front bars of a grate.

Theſe balls have one advantage, which is peculiar to them, and which might perhaps recommend the uſe of them to the curious, even in fire-places conſtructed on the beſt principles; they cauſe the cinders to be conſumed almoſt entirely; and even the very aſhes may be burnt, or made to diſappear, if care be taken to throw them repeatedly upon the fire when it burns with an intenſe heat. It is not difficult to account for this effect in a ſatisfactory manner, and in accounting for it we ſhall explain a circumſtance on which it is probable that the great increaſe of the heat of an open fire, where theſe balls are uſed, may, in ſome meaſure, depend. The ſmall particles of coal and of cinder which, in a common fire, fall through the bottom of the grate and eſcape combuſtion, when theſe balls are uſed can hardly fail to fall and lodge on ſome of them; and, as they are intenſely hot, theſe ſmall bodies which alight upon them in their fall, are ſoon heated red-hot, and diſpoſed to take fire and burn; and, as freſh air from below the grate is continually making its way upwards amongſt the balls, every circumſtance is highly favourable to the rapid and complete combuſtion of theſe ſmall inflammable bodies. But if theſe ſmall pieces of coal and cinder ſhould, in their fall, happen to alight upon the metallic bars which form the bottom of the grate; as theſe bars are conductors of heat, and, on account of that circumſtance, as well as of their ſituation, *below* the fire, never can be made very hot, any ſmall particle of fuel that happens to come into contact with them, not only cannot take fire, but would ceaſe to burn ſhould it arrive in a ſtate of actual combuſtion.

Theſe facts are very important, and well deſerving of the attention of thoſe who may derive advantage from the improvement of fire-places, and the œconomy of fuel.

There are ſome circumſtances which ſtrongly indicate that an admixture of incombuſtible bodies with fuel, and eſpecially with coal, cauſe an increaſe of the heat even when the fuel is burnt in a cloſed fire-place. No fire-place can well be contrived more completely cloſed than thoſe of the iron ſtoves in common uſe in the Netherlands; but in theſe ſtoves, which are heated by coal fires, a large proportion of wet clay is always coarſely mixed with the coals before they are introduced into the fire-place. If this practice had not been found to be uſeful,

useful, it would certainly never have obtained generally; nor would it have been continued, as it has been, for more than two hundred years.

The combination of different substances, combustible and incombustible, to form, artificially, various kinds of cheap and pleasant fuel, particularly adapted for the different processes in which the fuel is employed, is a subject well worthy of the attention of enterprizing and ingenious men. How much excellent fuel, for instance, might be made, with proper additions and proper management, of the mountains of refuse coal-dust that lie useless at the mouths of coal-pits? and how much would it contribute to cleanliness and elegance if the use of improved coke, or of hard and light fire-balls, could be generally introduced in our houses and kitchens, instead of crude, black, powdery, dirty sea-coal! Of the great œconomy that would result from such a change, there cannot be the smallest doubt.

It is a melancholy truth, but, at the same time, a most indisputable fact, that, while the industry and ingenuity of millions are employed, with unceasing activity, in inventing, improving, and varying, those superfluities which wealth and luxury introduce into society, no attention whatever is paid to the improvement of those common necessaries of life on which the subsistence of all, and the comforts and enjoyments of the great majority of mankind, absolutely depend.

Much will be done for the benefit of society, if means can be devised to call the attention of the active and benevolent to this long neglected, but most interesting, subject.

The Royal Institution seems to be well calculated to facilitate and expedite the accomplishment of this important object. Indeed, it is more than probable that this precisely is the object which was principally had in view in the foundation and arrangement of that establishment.

VIII. *On the Use of Steam as a Vehicle for conveying Heat from one Place to another.* By Count RUMFORD*.

MORE than fifty years ago, colonel William Cook, in a paper presented by him to the Royal Society, and published in their Transactions, made a proposal for warming rooms by means of metallic tubes filled with steam, and communicating with a boiler situated out of the room; which proposal was accompanied by an engraving, which

* From the *Journals of the Royal Institution of Great Britain*, vol. i.

showed,

ſhowed, in a manner perfectly clear and diſtinct, how this might be effected. Since that time this ſcheme has frequently been put in practice, with ſucceſs, both in this country and on the continent*. Many attempts have likewiſe been made, at different periods, to heat liquids by means of ſteam introduced into them; but moſt of theſe have failed: and, indeed, until it was known that fluids are nonconductors of heat, and, conſequently, that heat cannot be made to *deſcend* in them (which is a recent diſcovery), theſe attempts could hardly ſucceed; for, in order to their being ſucceſsful, it is abſolutely neceſſary that the tube which conveys the hot ſteam ſhould open into the loweſt part of the veſſel which contains the liquid to be heated, or on a level with its bottom;—but as long as the erroneous opinion obtained, that heat could paſs in fluids in all directions, there did not appear to be any reaſon for placing the opening of the ſteam-tube at the bottom of the veſſel, while many were at hand which pointed out other places as being more convenient for it.

But to ſucceed in heating liquids by ſteam, it is neceſſary, not only that the ſteam ſhould enter the liquid at the bottom of the veſſel which contains it, but alſo that it ſhould enter it coming from above. The ſteam-tube ſhould be in a vertical poſition, and the ſteam ſhould *deſcend* through it previous to its entering the veſſel, and mixing with the liquid which it is to heat; otherwiſe, this liquid will be in danger of being forced back by this opening into the ſteam-boiler; for the hot ſteam, being ſuddenly condenſed on coming into contact with the cold liquid, a vacuum will neceſſarily be formed in the end of the tube; into which vacuum the liquid in the veſſel, preſſed by the whole weight of the incumbent atmoſphere, will ruſh with great force and with a loud noiſe; but if this tube be placed in a vertical poſition, and if it be made to riſe to the height of ſix or ſeven feet, the liquid which is thus forced into its lower end will not have time to riſe to that height before it will be met by ſteam, and obliged to return back into the veſſel. There will be no difficulty in arranging the apparatus in ſuch a manner as effectually to prevent the liquid to be heated from being forced backwards into the ſteam-boiler; and, when this is done, and ſome other neceſſary precautions to prevent accidents are taken, ſteam may be employed with great advantage for heating

* Although one ſhould naturally imagine that the notoriety of theſe facts would have been ſufficient to prevent all attempts in our days to claim a right to this invention, yet it is ſaid that a patent for it was taken out only a few years ago.

liquids,

liquids, and for keeping them hot, in a variety of caſes, in which fire, applied immediately to the bottoms of the containing veſſels, is now uſed.

In dyeing, for inſtance, and in brewing, and in the proceſſes of many other arts and manufactures, the adoption of this method of applying heat would be attended, not only with a great ſaving of labour and of fuel, but alſo of a conſiderable ſaving of expenſe in the purchaſe and repairs of boilers, and of other expenſive machinery: for, when ſteam is uſed inſtead of fire for heating their contents, boilers may be made extremely thin and light; and, as they may eaſily be ſupported and ſtrengthened by hoops and braces of iron, and other cheap materials, they will coſt but little, and ſeldom ſtand in need of repairs. To theſe advantages we may add others of ſtill greater importance: boilers intended to be heated in this manner may, without the ſmalleſt difficulty, be placed in any part of a room at any diſtance from the fire, and in ſituations in which they may be approached freely on every ſide. They may, moreover, eaſily be ſo ſurrounded with wood, or with other cheap ſubſtances which form warm covering, as moſt completely to confine the heat within them, and prevent its eſcape. The tubes, by which the ſteam is brought from the principal boiler, (which tubes may conveniently be ſuſpended juſt below the ceiling of the room,) may, in like manner, be covered ſo as almoſt entirely to prevent all loſs of heat by the ſurfaces of them; and this to whatever diſtances they may be made to extend.

In ſuſpending theſe ſteam-tubes, care muſt, however, be taken to lay them in a ſituation *not perfectly horizontal* under the ceiling, but to incline them at a ſmall angle, making them riſe gradually from their junction with the top of a large vertical ſteam-tube, connecting them with the ſteam-boiler, quite to their fartheſt extremities: for, when theſe tubes are ſo placed, it is evident that all the water formed in them, in conſequence of the condenſation of the ſteam in its paſſage through them, will run backwards and fall into the boiler, inſtead of accumulating in them, and obſtructing the paſſage of the ſteam, which it would not fail to do were there any conſiderable bends or wavings, upwards and downwards, in theſe tubes, or of running forward and deſcending with the ſteam into the veſſels containing the liquids to be heated, which would happen if theſe tubes inclined downwards inſtead of inclining upwards as they recede from the boiler.

In order that clear and diſtinct ideas may be formed of the various parts of this apparatus, even without figures, I ſhall diſtinguiſh each part by a ſpecific name. The veſſel in which water

water is boiled in order to generate ſteam, and which, in its conſtruction, may be made to reſemble the boiler of a ſteam-engine, I ſhall call the *ſteam-boiler:* the vertical tube, which, riſing up from the top of the boiler, conveys the ſteam into the tubes (nearly horizontal), which are ſuſpended from the ceiling of the room, I ſhall call the *prime conductor:* to the horizontal tubes I ſhall give the name of *horizontal conductors*, or ſimply, *conductors of ſteam:* and to the (ſmaller) tubes, which, deſcending perpendicularly from theſe *horizontal conductors*, convey the ſteam to the liquids which are to be heated, I ſhall, excluſively, appropriate the appellation of *ſteam-tubes*.

The veſſels in which the liquids are put that are to be heated, I ſhall call the *containing veſſels*. Theſe veſſels may be made of any form; and, in many caſes, they may, without any inconvenience, be conſtructed of wood, or of other cheap materials, inſtead of being made of coſtly metals, by which means a very heavy expenſe may be avoided.

Each ſteam-tube muſt deſcend perpendicularly from the horizontal conductor, with which it is connected, to the level of the bottom of the containing veſſel to which it belongs; and, moreover, muſt be furniſhed with a good braſs cock, perfectly ſteam-tight; which may beſt be placed at the height of about ſix feet above the level of the floor of the room.

This ſteam-tube may either deſcend within the veſſel to which it belongs, or on the outſide of it, as ſhall be found moſt convenient. If it comes down on the outſide of the veſſel, it muſt enter it at its bottom, by a ſhort horizontal bend; and its junction with the bottom of the veſſel muſt be well ſecured, to prevent leakage. If it comes down into the veſſel, on the inſide of it, it muſt deſcend to the bottom of it, or at leaſt to within a very few inches of the bottom of it, otherwiſe the liquid in the veſſel will not be uniformly and equally heated.

When the ſteam-tube is brought down on the inſide of the containing veſſel, it may either come down perpendicularly, and without touching the ſides of it, or it may come down on one ſide of the veſſel, and in contact with it.

When ſeveral ſteam-tubes, belonging to different containing veſſels, are connected with one and the ſame horizontal ſteam conductor, the upper end of each of theſe tubes, inſtead of being ſimply attached, by ſoldering, to the under ſide of the conductor, muſt enter, at leaſt one inch, within the cavity of it; otherwiſe the water reſulting from a condenſation of a part of the ſteam in the conductor, by the cold air which ſurrounds it, inſtead of finding its way back into

the ſteam-boiler, will deſcend through the ſteam-tubes and mix with the liquids in the veſſels below; but when the open ends of theſe tubes project upwards within the ſteam conductor, though it be but to a ſmall height above the level of its under ſide, it is evident that this accident cannot happen.

It is not neceſſary to obſerve here, that, in order that the ends of the ſteam-tubes may project within the horizontal conductor, the diameters of the former muſt be conſiderably leſs than the diameter of the latter.

To prevent the loſs of heat ariſing from the cooling of the different tubes through which the ſteam muſt paſs in coming from the boiler, all thoſe tubes ſhould be well defended from the cold air of the atmoſphere by means of warm covering; but this may eaſily be done, and at a very trifling expenſe. The horizontal conductors may be incloſed within ſquare wooden tubes, and ſurrounded on every ſide by charcoal-duſt, fine ſawduſt, or even by wool; and the ſteam-tubes and prime conductor may be ſurrounded, firſt by three or four coatings of ſtrong paper, firmly attached to them by paſte or glue, and covered with a coating of varniſh, and then by a covering of thick coarſe cloth. It will likewiſe be adviſable to cover the horizontal conductors with ſeveral coatings of paper; for, if the paper be put on to them while it is wet with the paſte or glue, and if care be taken to put it on in long ſlips or bands, wound regularly round the tube in a ſpiral line, from one end of it to the other, this covering will be uſeful, not only by confining more effectually the heat, but alſo by adding very much to the ſtrength of the tube, and rendering it unneceſſary to employ thick and ſtrong ſheets of metal in the conſtruction of it.

However extraordinary and incredible it may appear, I can aſſert it as a fact, which I have proved by repeated experiments, that if a hollow tube, conſtructed of ſheet copper $\frac{1}{20}$ of an inch in thickneſs, be covered by a coating only twice as thick, or $\frac{1}{10}$ of an inch in thickneſs, formed of layers of ſtrong paper, firmly attached to it by good glue, the ſtrength of the tube will be more than doubled by this covering. I found by experiments the moſt unexceptionable and deciſive, (of which I intend, at ſome future period, to give to the public a full and detailed account,) that the ſtrength of paper is ſuch, when ſeveral ſheets of it are firmly attached together with glue, that a ſolid cylinder of this ſubſtance, the tranſverſe ſection of which ſhould amount to only one ſuperficial inch, would ſuſtain a weight of 30,000 lbs. avoirdupois, or above 13 tons, ſuſpended to it, without being pulled aſunder or broken. The ſtrength of hemp is ſtill much

much greater, when it is pulled equally, in the direction of the length of its fibres. I found, from the results of my experiments with this substance, that a cylinder of the size above mentioned, composed of the straight fibres of hemp, glued together, would sustain 92,000 lbs. without being pulled asunder.

A cylinder, of equal dimensions, composed of the strongest iron I could ever meet with, would not sustain more than 66,000 lbs. weight; and the iron must be very good not to be pulled asunder with a weight equal to 55,000 lbs. avoirdupois.

I shall not, in this place, enlarge on the many advantages that may be derived from a knowledge of these curious facts. I have mentioned them now in order that they may be known to the public; and that ingenious men, who have leisure for these researches, may be induced to turn their attention to a subject, not only very interesting on many accounts, but which promises to lead to most important improvements in mechanics.

I cannot return from this digression without just mentioning one or two results of my experimental investigations relative to the force of cohesion, or strength of bodies, which, certainly, are well calculated to excite the curiosity of men of science.

The strength of bodies of different sizes, similar in form, and composed of the same substance, or the forces by which they resist being pulled asunder by weights suspended to them, and acting in the direction of their lengths; are not in the simple ratio of the areas of their transverse sections, or of their fractures, but in a higher ratio, and this ratio is different in different substances.

The form of a body has a considerable influence on its strength, even when it is pulled in the direction of its length.

All bodies, even the most brittle, appear to be torn asunder, or their particles separated, or fibres broken, one after the other; and hence it is evident, that that form must be most favourable to the strength of any given body, pulled in the direction of its length, which enables the greatest number of its particles, or longitudinal fibres, to be separated to the greatest possible distance (short of that at which the force of cohesion is overcome), before any of them have been forced beyond that limit.

It is more than probable, that the apparent strength of different substances depends much more on the number of their particles that come into action before any of them are forced beyond the limits of the attraction of cohesion, than on any

ſpecific difference in the intenſity of that force in thoſe ſubſtances.

But to return to the ſubject more immediately under conſideration. As it is eſſential that the ſteam employed in heating liquids, in the manner before deſcribed, ſhould enter the containing veſſel at, or very near, its bottom, it is evident that this ſteam muſt be ſufficiently ſtrong, or elaſtic, to overcome, not only the preſſure of the atmoſphere, but alſo the additional preſſure of the ſuperincumbent liquid in the veſſel; the ſteam-boiler muſt therefore be made ſtrong enough to confine the ſteam, when its elaſticity is ſo much increaſed by means of additional heat, as to enable it to overcome that reſiſtance. This increaſe of the elaſtic force of the ſteam need not, however, in any caſe, exceed a preſſure of five or ſix pounds upon a ſquare inch of the boiler, or one-third part, or one-half, of an atmoſphere.

It is not neceſſary for me to obſerve here, that in this, and alſo in all other caſes where ſteam is uſed as a vehicle for conveying heat from one place to another, it is indiſpenſably neceſſary to provide ſafety-valves of two kinds; the one for letting a part of the ſteam eſcape, when, on the fire being ſuddenly increaſed, the ſteam becomes ſo ſtrong as to expoſe the boiler to the danger of being burſt by it; the other for admitting air into the boiler, when, in conſequence of the diminution of the heat, the ſteam in the boiler is condenſed, and a vacuum is formed in it; and when, without this valve, there would be danger, either of having the ſides of the boiler cruſhed, and forced inwards by the preſſure of the atmoſphere from without; or of having the liquid in the containing veſſels forced upwards into the horizontal ſteam conductors, and from thence into the ſteam-boiler. This laſt-mentioned accident, however, cannot happen, unleſs the cocks in ſome of the ſteam-tubes happen to be open. The two valves effectually prevent all accidents.

The reader will, no doubt, be more diſpoſed to pay attention to what has here been advanced, on this intereſting ſubject, when he is informed that the propoſed ſcheme has already been executed on a very large ſcale, and with complete ſucceſs, and that the above details are little more than exact deſcriptions of what actually exiſts.

A great mercantile and manufacturing houſe at Leeds, that of Meſſrs. Gott and Co., had the courage, notwithſtanding the mortifying prediction of all their neighbours, and the ridicule with which the ſcheme was attempted to be treated, to erect a dyeing-houſe, on a very large ſcale indeed, on the principles here deſcribed and recommended.

On

On my viſit to Leeds the laſt ſummer, I waited on Mr. Gott, who was then mayor of the town, and who received me with great politeneſs, and ſhowed me the cloth halls, and other curioſities of the place; but nothing he ſhowed me intereſted me half ſo much as his own truly noble manufactory of ſuperfine woollen cloths. I had ſeen few manufactories ſo extenſive, and none ſo complete in all its parts. It was burnt to the ground the year before I ſaw it, and had juſt been rebuilt, on a larger ſcale, and with great improvements in almoſt every one of its details. The reader may eaſily conceive that I felt no ſmall degree of ſatisfaction on going into the dyeing-houſe to find it fitted up on principles which I had had ſome ſhare in bringing into repute, and which Mr. Gott told me he had adopted in conſequence of the information he had acquired in the peruſal of my ſeventh Eſſay. He aſſured me that the experiment had anſwered, even far beyond his moſt ſanguine expectations; and, as a ſtrong proof of the utility of the plan, he told me that his next door neighbour, who is a dyer by profeſſion, and who, at firſt, was ſtrongly prejudiced againſt theſe innovations, has lately adopted them, and is now convinced that they are real improvements. Mr. Gott aſſured me that he had no doubt but that they would be adopted by every dyer in Great Britain in the courſe of a very few years.

The dyeing-houſe of Meſſrs. Gott and Co. which is ſituated on the ground floor of the principal building of the manufactory, is very ſpacious, and contains a great number of coppers of different ſizes; and as theſe veſſels, ſome of which are very large, are diſtributed about promiſcuouſly, and apparently without any order in their arrangement, in two ſpacious rooms, (each copper appearing to be inſulated, and to have no connection whatever with the others,) all of them together form a very ſingular appearance. The rooms are paved with flat ſtones, and the brims of all the coppers, great and ſmall, are placed at the ſame height, about three feet, above the pavement. Some of theſe coppers contain upwards of 1800 gallons; and they are all heated by ſteam from one ſteam-boiler, which is ſituated in a corner of one of the rooms.

The horizontal tubes, which ſerve to conduct the ſteam from the boiler to the coppers, are ſuſpended juſt below the ceiling of the rooms: they are made, ſome of lead, and ſome of caſt iron, and are from four to five inches in diameter; but when I ſaw them they were naked, or without any covering to confine the heat. On my obſerving to Mr. Gott, that coverings for them would be uſeful, he told me that it was

intended that they ſhould be covered, and that coverings would be provided for them.

The vertical ſteam-tubes, by which the ſteam paſſes down from the horizontal ſteam conductors into the coppers, are all conſtructed of lead, and are from $\frac{3}{4}$ of an inch to $2\frac{1}{2}$ inches in diameter; being made larger or ſmaller according to the ſizes of the coppers to which they belong. Theſe ſteam-tubes all paſs down on the outſides of their coppers, and enter them horizontally at the level of their bottoms. Each copper is furniſhed with a braſs cock for letting off its contents; and it is filled with water from a ciſtern at a diſtance, which is brought to it by a leaden pipe. The coppers are all ſurrounded by thin circular brick walls, which ſerve not only to ſupport the coppers, but alſo to confine the heat.

The rapidity with which theſe coppers may be heated, by means of ſteam, is truly aſtoniſhing. Mr. Gott aſſured me that one of the largeſt of them, containing upwards of 1800 gallons, when filled with cold water from the ciſtern, requires no more than half an hour to heat it till it actually boils! By the greateſt fire that could be made under ſuch a copper, with coals, it would hardly be poſſible to make it boil in leſs than an hour.

It is eaſy to perceive that the ſaving of time which will reſult from the adoption of this new mode of applying heat will be very great; and it is likewiſe evident that it may be increaſed, almoſt without limitation, merely by augmenting the diameter of the ſteam-tube: care muſt, however, be taken that the boiler be ſufficiently large to furniſh the quantities of ſteam required. The ſaving of fuel will alſo be very conſiderable: Mr. Gott informed me that, from the beſt calculation he had been able to make, it would amount to near two-thirds of the quantity formerly expended, when each copper was heated by a ſeparate fire.

But theſe ſavings are far from being the only advantages that will be derived from the introduction of theſe improvements in the management of heat: there is one, of great importance indeed, not yet mentioned, which alone would be ſufficient to recommend the very general adoption of them. As the heat communicated by ſteam can never exceed the mean temperature of boiling water by more than a very few degrees, the ſubſtances expoſed to it can never be injured by it. In many arts and manufactures this circumſtance will be productive of great advantages, but in none will its utility be more apparent than in cookery, and eſpecially in public kitchens, where great quantities of food are prepared in large boilers; for, when the heat is conveyed in this manner, all

the labour now employed in ſtirring about the contents of thoſe boilers, to prevent the victuals from being ſpoiled by burning to the bottoms of them, will be unneceſſary, and the loſs of heat occaſioned by this ſtirring prevented; and, inſtead of expenſive coppers, or metallic boilers, which are difficult to be kept clean, and often ſtand in need of repairs, common wooden tubs may, with great advantage, be uſed as culinary veſſels; and their contents may be heated by portable fire-places, by means of ſteam-boilers attached to them.

As theſe portable fire-places and their ſteam-boilers may, without the ſmalleſt inconvenience, be made of ſuch weight, form, and dimenſions, as to be eaſily tranſported from one place to another by two men, and be carried through a doorway of the common width, (with this machinery, and the ſteam-tubes belonging to it, and a few wooden tubs,) a complete public kitchen, for ſupplying the poor, and others, with ſoups; and alſo with puddings, vegetables, meat, and all other kinds of food prepared by boiling, might be eſtabliſhed in half an hour, in any room in which there is a chimney (by which the ſmoke from the portable fire-place can be carried off); and, when the room ſhould be no longer wanted as a kitchen, it might, in a few minutes, be cleared of all this culinary apparatus, and made ready to be uſed for any other purpoſe.

This method of conveying heat is peculiarly well adapted for heating baths; it is likewiſe highly probable that it would be found uſeful in the bleaching buſineſs, and in waſhing linen. It would alſo be very uſeful in all caſes where it is required to keep any liquid at about the boiling point for a long time without making it boil; for the quantity of heat admitted may be very nicely regulated by means of the braſs cock belonging to the ſteam-tube. Mr. Gott ſhowed me a boiler in which ſhreds of ſkins were digeſting in order to make glue, which was heated in this manner; and in which the heat was ſo regulated, that, although the liquid never actually boiled, it always appeared to be upon the very point of beginning to boil.

This temperature had been found to be beſt calculated for making good glue. Had any other *lower* temperature been found to anſwer better, it might have been kept up with the ſame caſe, and with equal preciſion, by regulating properly the quantity of ſteam admitted.

I need not ſay how much this country is obliged to Mr. Gott and his worthy colleagues. To the ſpirited exer-

tions of ſuch men, who abound in no other country, we owe one of the proudeſt diſtinctions of our national character—that of being an enlightened and an enterpriſing people.

IX. *An Account of a new Eudiometer. By Mr.* Davy*.

THE dependance of the health and exiſtence of animals upon a peculiar ſtate of the atmoſphere, and the relations of this ſtate to proceſſes connected with the moſt eſſential wants of life, have given intereſt and importance to inquiries concerning the compoſition and properties of atmoſpheric air.

This elaſtic fluid has been long known to conſiſt chiefly of oxygen and nitrogen mingled together, or in a ſtate of looſe combination, and holding in ſolution water.

A variety of proceſſes have been inſtituted with the view of determining the relative proportions of the two gaſes, but moſt of them have involved ſources of inaccuracy; and lately all, except two (the ſlow combuſtion of phoſphorus, and the action of liquid ſulphurets,) have been generally abandoned.

Both phoſphorus and ſolution of ſulphuret of potaſh abſorb the whole of the oxygen of atmoſpheric air at common temperatures, and they do not materially alter the volume, or the properties of the reſidual nitrogen; but their operation is extremely ſlow, and in many caſes it is difficult to aſcertain the period at which the experiment is completed.

I have lately employed as an eudiometrical ſubſtance the ſolution of green muriate, or ſulphate, of iron, impregnated with nitrous gas; and I have found that it is in ſome reſpects ſuperior to many of the bodies heretofore uſed, as it rapidly condenſes oxygen without acting upon nitrogen, and requires for its application only a very ſimple and a very portable apparatus.

This fluid is made by tranſmitting nitrous gas through green muriate, or ſulphate, of iron, diſſolved to ſaturation in water†. As the gas is abſorbed, the ſolution becomes of a deep olive-brown, and when the impregnation is completed it appears opaque and almoſt black. The proceſs is apparently owing to a ſimple elective attraction; in no caſe is the gas decompoſed; and under the exhauſted receiver it aſſumes its

* From the *Journals of the Royal Inſtitution of Great Britain*, vol. i.

† Dr. Prieſtley firſt obſerved this proceſs: for a particular account of it, ſee Reſearches, Chemical and Philoſophical, p. 152. Johnſon.

elaſtic

elaſtic form, leaving the fluid, with which it was combined, unaltered in its properties.

The inſtruments neceſſary for aſcertaining the compoſition of the atmoſphere, by means of impregnated ſolutions, conſiſt ſimply of a ſmall graduated tube, having its capacity divided into one hundred parts, and greateſt at the open end; and of a veſſel for containing the fluid.

The tube, after being filled with the air to be examined, is introduced into the ſolution; and, that the action may be more rapid, gently moved from a perpendicular towards a horizontal poſition. Under theſe circumſtances the air is rapidly diminiſhed; and, in conſequence of the dark colour of the fluid, it is eaſy to diſcover the quantity of abſorption. In a few minutes the experiment is completed, and the whole of the oxygen condenſed by the nitrous gas in the ſolution in the form of nitrous acid.

In all eudiometrical proceſſes with impregnated ſolutions, the period at which the diminution is at a ſtand muſt be accurately obſerved; for, ſhortly after this period, the volume of the reſidual gas begins to be a little increaſed, and, after ſome hours, it will often fill a ſpace greater by ſeveral of the hundred parts on the ſcale of the tube, than that which it occupied at the maximum of abſorption.

This circumſtance depends upon the ſlow decompoſition of the nitrous acid (formed during the experiment) by the green oxide of iron, and the conſequent production of a ſmall quantity of aëriform fluid (chiefly nitrous gas)*; which, having no affinity for the red muriate, or ſulphate, of iron produced, is gradually evolved, and mingled with the reſidual nitrogen.

The impregnated ſolution with green muriate is more rapid in its operation than the ſolution with green ſulphate. In caſes when theſe ſalts cannot be obtained in a ſtate of abſolute purity, the common or mixed ſulphate of iron may be employed. One cubic inch of moderately ſtrong impregnated ſolution is capable of abſorbing five or ſix cubic inches of oxygen, in common proceſſes; but the ſame quantity muſt never be employed for more than one experiment.

A number of comparative experiments, made on the conſtitution of the atmoſphere at the Hotwells, Briſtol, in July,

* The decompoſition of nitrous acid, by ſolutions containing oxyde of iron, at its minimum of oxydation, is a very complex proceſs. The green oxyde, during its converſion into red oxyde, not only decompoſes the acid, but likewiſe acts upon the water of the ſolution; and ammoniac is ſometimes formed, and ſmall portions of nitrous oxyde and nitrogene evolved with the nitrous gas.

Auguſt, and September, 1800, with phoſphorus, ſulphurets of alkalies, and impregnated ſolution, demonſtrated the accuracy of the proceſſes in which the laſt ſubſtance was properly employed. The diminutions given by the ſulphurets were indeed always greater, by a minute quantity, than thoſe produced by phoſphorus and impregnated ſolutions: but the reaſon of this will be obvious to thoſe who have ſtudied the ſubject of Eudiometry. In no inſtance was it found that 100 parts in volume of air contained more than 21 of oxygen: and the variations connected with different winds, and different ſtates of temperature, moiſture, &c. were too ſmall, and too often related to accidental circumſtances, to be accurately noticed.

In analyſing the atmoſphere in different places, by means of impregnated ſolutions, I have never been able to aſcertain any notable difference in the proportions of its conſtituent parts. Air, collected on the ſea at the mouth of the Severn, on October the 3d, 1800, which muſt have paſſed over much of the Atlantic, as the wind was blowing ſtrong from the weſt, was found to contain 21 per cent. of oxygen in volume; and this was nearly the proportion in air ſent from the coaſt of Guinea, to Dr. Beddoes, by two ſurgeons of Liverpool.

If we compare theſe reſults with the reſults gained more than twenty years ago, by Mr. Cavendiſh, from experiments on the compoſition of atmoſpherical air, made at London and Kenſington; conſidering, at the ſame time, the reſearches of Berthollet in Egypt and at Paris, and thoſe of Marti in Spain, we ſhall find ſtrong reaſons for concluding that the atmoſphere, in all places expoſed to the influence of the winds, contains very nearly the ſame proportions of oxygen and nitrogen: a circumſtance of great importance; for, by teaching us that the different degrees of ſalubrity of air do not depend upon differences in the quantities of its principal conſtituent parts, it ought to induce us to inſtitute reſearches concerning the different ſubſtances capable of being diſſolved or ſuſpended in the air, which are noxious to the human conſtitution; particularly as an accurate knowledge of their nature and properties would probably enable us, in a great meaſure, to guard againſt, or deſtroy, their baneful effects.

X. *An Account of the Improvements of the Port of London, and more particularly of the intended Bridge, conſiſting of a ſingle Arch of* 600 *Feet Span.*

NOTHING tends ſo much to promote the improvements of a ſtate, as the eſtabliſhing of an eaſy and uninterrupted communication through all its diſtricts. It has therefore been a leading object with every well-wiſher of his country, to render the general intercourſe as perfect and convenient as poſſible. Public roads and bridges have been the means chiefly employed to eſtabliſh this intercourſe: bridges, as requiring ſcientific and mechanical knowledge, and, in many caſes, the utmoſt exertions of talents and ſkill, have frequently engaged the attention of perſons of eminence and learning.

It would be an amuſing taſk to trace the progreſs of this uſeful art, from the rude efforts of the ſavage, in his unaſſiſted ſtate, to the magnificent works of civilized nations, when ſcience, wealth, and increaſed population, have united to overcome difficulties conſidered before as unſurmountable.

When a work is to be performed, mankind, at firſt, make uſe of the materials which are neareſt at hand, and which require the leaſt ſkill in the preparation; timber and ſtone were therefore the materials with which bridges were firſt conſtructed, and thoſe edifices have been rendered more or leſs perfect, in proportion to the quality of the materials, the ſtate of the arts, and the degree of wealth and power, in the countries in which they were erected.

In our oldeſt bridges, it is evident, there has been much timidity, and only a ſmall portion of ſkill: in deep water, the lower parts of the piers have been conſtructed with timber, and the maſonry begins to take place at the line of low water; the arches are of narrow ſpan, and the maſonry employed in them is frequently compoſed, partly of rubble, and partly of ſquared ſtone. In time, means were deviſed (by uſing coffer-dams and caiſſoons) to place the maſonry as low, commonly lower than the natural bed of the river; the arches were alſo formed of a bolder ſpan, and the maſonry was made much more perfect, being all of ſquared ſtone. In this manner, bridges have been conſtructed in Italy, France, and the Britiſh iſles, which have juſtly been conſidered, not only as works of general utility, but of great magnificence.

In like manner, timber bridges have been gradually improved, from the rough trunk of a tree thrown acroſs a ſmall ſtream,

ſtream, to the bold and ingenious labours of the Swiſs carpenter at Schaffhauſen

Bridges continued to be chiefly compoſed of timber or of ſtone, till of late years: on account of œconomy, in ſome caſes, they have been built with bricks.

Metals not being generally found in a pure ſtate, require much labour and expenſe to make them ſubſervient to the purpoſes of man, and therefore, in the uncultivated periods of ſociety, were not applied to works of great magnitude; but the important improvements in chemical and mechanical knowledge, have, in a great degree, removed thoſe difficulties, and rendered them not only the moſt powerful, but the moſt uſeful means of man.

Iron being the moſt abundant, cheap, and generally uſeful, of all the metals, has of late years been applied in all works where great ſtrength was required in proportion to the weight of the material: hence cylinders, beams and pumps for ſteam-engines, boats * and barges for canals and navigable rivers, beams † and pillars for large buildings and bridges, have been conſtructed of iron.

The firſt iron bridge we know of, is over the river Severn, near Coalbrookdale, in Shropſhire; it conſiſts of one arch 100 feet and 6 inches in the ſpan, and riſes 45 feet: there are five ribs, each caſt in two pieces, ſecured where they join at the crown of the arch by a caſt-iron key plate, and connected together, horizontally and vertically, by caſt-iron braces, formed with dovetails and forelocks; the ribs are covered with caſt-iron plates, and the railing to the ſides is of iron: the total weight of iron is 378$\frac{1}{2}$ tons. The project's being carried into execution was chiefly owing to the genius and exertions of Mr. John Wilkinſon and Mr. Abraham Darley, iron maſters, whoſe ſcientific knowledge and extenſive practice, in all that regards the manufacture of iron, have long been known to the public. The bridge was built by Mr. Abraham Darley, and the iron work was caſt at Coalbrookdale in the year 1779. It was a bold effort; for, in the firſt inſtance of adopting a new material, they exceeded the ſpan of the centre arch of Blackfriars bridge, which had been conſidered as a great exertion with ſtone.

* Mr. John Wilkinſon has conſtructed boats and barges of iron, ſome of which are uſed on the river Severn, and the others upon the canals in Staffordſhire and Worceſterſhire.

† A large manufactory for ſpinning flax into thread, by machinery worked by a ſteam-engine, has been erected at Shrewſbury by Meſſrs Benyon, Marſhall, and Bage, where there are four heights of floors, and a roof compoſed of brick arches, which are ſupported by caſt-iron beams and pillars.

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The iron work of this bridge has fully juſtified the idea of making uſe of that metal; for it is at this time as perfect as when it was firſt put up, except the cracking of ſome of the ſmall pieces, owing to the giving way of the abutments of ſtone, which, it is to be regretted, were not made ſufficiently ſtrong to oppoſe the great maſs of alluvial earth, of which the very high and ſteep adjoining banks are compoſed; for, if thoſe abutments had been fortunately built on the coal meaſures, no ſuch ſlip could have taken place.

The ſecond iron bridge was built over the ſame river, about two miles above the former one, at a place called Buildwas; it was erected at the expenſe of the county of Salop, agreeably to a plan, and under the direction, of Mr. Telford, who is employed as ſurveyor of the public works of that county: it was alſo caſt at Coalbrookdale in 1795 and 1796. It conſiſts of one arch 130 feet in the ſpan, and riſes, from the ſpringing to the ſoffit of the arch, 27 feet. In this bridge, as it was neceſſary to keep the roadway as low as poſſible, the principle of the Schaffhauſen bridge is in ſome degree adopted; for the outſide ribs are made to go up as high as the tops of the railing; they are connected with the ribs that bear the covering plates by means of pieces of iron, dovetailed in the form of king-poſts. The plates which form the covering over the lower ribs are caſt with deep flanches, are laid cloſe to each other, and form an arch of themſelves, ſo that, altogether, the bridge is compact and firm. The weight of iron is 173 tons, 18½ cwt. Some ſmaller bridges, and an aqueduct at Longdon, (the firſt made of iron over a navigable canal,) have alſo been made under Mr. Telford's directions, in Shropſhire.

The next bridge, on a large ſcale, which was made of iron, was that over the river Wear, at Monk-wearmouth, in the county of Durham. This bridge is 236 feet in the ſpan, and the arch riſes only 34 feet: it is compoſed of very ſhort caſt-iron frames, which are connected together by bars of wrought iron, and hollow tubes with flanches and ſcrews; the ribs are covered with timber planking. The weight of caſt iron uſed in this bridge is 205 tons, hammered iron 55 tons. This bridge was built under the direction, and chiefly at the expenſe, of Rowland Burdon, eſq.; it was caſt at the manufactory of Meſſrs. Walkers, of Rotherham, in Yorkſhire, and does much honour to the projector and to the iron maſters. It was a conſiderable ſtep in the practice of bridge building, being nearly double the ſpan of the arch of Buildwas, and conſiderably more than double that of the centre arch of Blackfriars bridge. This will, perhaps, appear raſh

to

to thoſe who have not had an oportunity of conſidering the qualities of iron, or who have not carefully compared its ſtrength with the ſtrength of the materials formerly uſed in conſtructing bridges. In great works it is proper we ſhould proceed with caution; but the very principle of improvement muſt be wholly abandoned, if the demonſtrations of ſcience and the evidence of practical knowledge are to be diſregarded. To thoſe who will take the trouble of comparing the ſpecific gravity and the ſtrength of caſt iron with thoſe of ſtone, it will not appear extraordinary, that by uſing that metal, the practice of bridge-building may be changed, and the openings of archways made to extend far beyond what has hitherto been attempted. The advantages to be derived from this practice are obvious, and become of great national importance in every country where the free navigation of rivers is intimately connected with its proſperity.

We have been led into the conſideration of this ſubject by the information we have received reſpecting the plans for rebuilding London bridge. Underſtanding that there was a plan for conſtructing a bridge over the Thames of a ſingle arch of caſt iron, we have made particular inquiries, and have authority to ſay that the following is a correct ſtatement of the hiſtory, principles, and plan of this deſign:

The manufactures, trade, and commerce of Great Britain having increaſed to an extent unparalleled in the hiſtory of nations, a great proportion of which is carried on through the metropolis by means of the fine river upon which it is ſituated, and the important centre it forms for the commerce of great part of the world; although this river forms an excellent channel to admit the intercourſe of ſhips of the largeſt burthen within a few miles of the city, yet, from the increaſe of the number and ſize of the veſſels frequenting the port of London, great inconveniences and loſſes have been experienced in tranſacting the buſineſs connected with the ſhipping. The diſtance at which the large ſhips are obliged to lie, the confuſion of ſhipping in the river, the loſs of time in loading and diſcharging goods, the expenſe of lighterage, the frequency of thefts, the delays and vexation experienced by the merchant and manufacturer, have at laſt given riſe to propoſitions and plans to remedy thoſe evils. On this great national ſubject, which embraces ſuch a variety of objects, opinions have, of courſe, been various, and ſome of them contradictory: this produced much diſcuſſion while the buſineſs remained with an open committee of the houſe of commons; and, although much uſeful information was obtained, yet no project appeared to be finally agreed on, and brought to maturity.

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This led to the judicious meaſure of appointing a ſelect committee, conſiſting of members who were not concerned in any of the projects brought forward. This committee has made three moſt valuable reports to the houſe of commons, wherein every thing relative to the port of London, and the general commerce of the kingdom, as far as it is connected with this port, has been arranged with an accuracy and preciſion which will enable the legiſlature and the public to comprehend, at one view, a ſubject which requires information beyond the power of any individual to bring together.

In this great plan, they have judiciouſly divided the port of London into three parts. The firſt is the docks in the Iſle of Dogs, which are calculated to accommodate the Weſt India trade, which, uſually arriving in large fleets, contributed in a peculiar degree to the crowded and embarraſſed ſtate of the river, and which, from the valuable nature of their cargoes, were very much expoſed to depredation. There is alſo, in this part, a canal, by means of which thoſe ſhips that wiſh to come up the river, may avoid the circuituous route by Greenwich and Deptford.

The ſecond part is the docks in Wapping, which are intended for the accommodation of ſeveral great branches of our trade which are ſubject to heavy duties. And

The third is, the improvement of the river from the Tower, upwards, to Blackfriars bridge; and this third part includes the rebuilding of London bridge. By this means, colliers and coaſting veſſels, and all veſſels of light burthen, are to be admitted to paſs the new London bridge, and ſhip and diſcharge goods immediately at wharfs and warehouſes, to be conſtructed along the banks of the river, and oppoſite to the centre of the city.

The two firſt parts of the plan have been ſanctioned by parliament, and have been undertaken by incorporated companies, excepting the canal, which is now executing under the direction of the city of London.

The committee have, in their third report, alſo recommended a general plan for improving the third or upper part of the port of London; that is, by removing the preſent London bridge, and replacing it with one of caſt iron, 65 feet high in the clear above high water, with inclined planes connecting it with the preſent ſtreets, and ſuch other improvements as may grow out of this alteration. Alſo, deepening the bed of the river, to admit of ſhips of two hundred tons lying afloat at low water; and contracting the width of the river, in order to preſerve its preſent velocity, and to acquire ſpace for wharfs and warehouſes, and for the inclined planes, without

without encroaching upon the property which is now connected with the ſhores.

The portion of this plan which has been more immediately under the conſideration of the committee during the preſent ſeſſions of parliament, has been a deſign by Meſſrs. Telford and Douglaſs, in which it is propoſed to conſtruct the bridge of a ſingle arch compoſed wholly of caſt iron: the ſpan of the arch is 600 feet, being the width to which, by Mr. Jeſſop's report, the river ought to be contracted, if it is excavated to have 13 feet at low water: the height in the clear above high water is 65 feet, being the elevation determined by the reſolution of the committee laſt ſeſſions.

The boldneſs and ſimplicity of this deſign render it an object of attention, not only to the committee, who are engaged in conſidering the further improvement of the port of London, but to men of ſcience and practical engineers, and to all who feel an intereſt in the improvement and credit of their country.

It is now generally admitted that the preſent London bridge ought to be removed, being expenſive and dangerous in itſelf, and forming an obſtruction in the moſt valuable part of the river. If the preſent bridge is to be removed, the new bridge ſhould be rebuilt upon that plan which ſhould leave the river clear of obſtacles, and, at the ſame time, reflect moſt credit on the Britiſh artiſts.

If a ſingle arch can be conſtructed without endangering the ſolidity and duration of the ſtructure, moſt undoubtedly there can be only one opinion as to the propriety of adopting it. It would be a great national work, combining the greateſt degree of utility and magnificence, and ſuperior in its kind to any thing the world has yet ſeen.

In a work of this nature it would have been imprudent to have been guided by the judgment or opinion of any individual; it therefore became neceſſary to collect the ſentiments of all the perſons moſt eminent for ſcientific knowledge and practical ſkill: this has been done by the committee in the moſt effectual and impartial manner that could be deviſed, by tranſmitting copies of the plans, explanatory drawings, and the queries relating thereto, to perſons who are well qualified to inveſtigate the ſubject: thoſe gentlemen have taken it up with an impartiality, candour, and patriotiſm, which does them much honour, and have furniſhed able and ſatisfactory demonſtrations and opinions. The reſult is, that an arch, of the plan and dimenſions referred to their conſideration, may be conſtructed ſo as to be rendered a ſubſtantial and durable edifice.

The

The particulars of these masterly disquisitions are contained in the Appendix to the fourth Report of the Select Committee for the further improvement of the port of London: they will be the means of throwing much new light on this important subject, and will, most probably, change the principles and practice of this species of architecture.

It would require many drawings and much detail to convey an adequate idea of the form and construction of this magnificent arch; it cannot properly be shown as whole in a drawing upon any scale that would suit a publication of this nature. We understand the public curiosity will be speedily gratified with a perspective view, taken from the Surrey side of the present London bridge, on a plate four feet long and two feet wide, and which, besides the new bridge, comprehends the principal objects in the cities of London and Westminster, from Bow church to Whitehall; and the proposed wharfs, warehouses, and terraces, between the bridges. The bridge part is engraved by that eminent artist Mr. Lowry, whose scientific knowledge is only exceeded by his dexterity as an engraver; and all the rest by Mr. Malton, whose views of London have done him honour, and qualify him to give the back ground with a precision which no other artist could be expected to equal.

According to this plan, the bridge is to be composed wholly of cast iron, which is much less liable to decay or alteration than hammered iron. The ribs are to be cast in portions of as large a size as to be conveniently moulded, and cast correctly; and such as can be readily managed in the removing and putting up: they are to be connected together by cross and diagonal tyes and braces, placed in such a manner that any of the pieces of the ribs or tyes, or braces, may be taken out separately, and be replaced without injury or interruption to the bridge. The ribs will receive the weight and pressure in a direction that the stress will operate upon the pieces of iron endways; therefore, before the bridge can give way, the iron must be crushed to pieces. All the frames or ribs are to be connected vertically and horizontally from the soffit of the arch to the roadway, so that the whole bridge will act as one frame, and by that means lessen the lateral pressure against the abutments, and guard against any error in the equilibration of the arch. The ribs are to be so disposed that they spread from the middle of the bridge to the abutments, with the view of causing the abutments to embrace a greater space on the shore, to increase the width of the bridge, to accommodate the roadway in turning towards the inclined planes, and to prevent any tendency the bridge might have to side vibrations:

vibrations: the ſide vibrations will be further oppoſed by the croſs and diagonal tyes and braces, and by the plate or grating which is to be laid acroſs the ribs to receive the roadway. The roadway is to be compoſed, firſt of a light, dry, and durable ſubſtance, laid next to the iron plates; ſecondly, of a compact ſubſtance, which will not admit of water paſſing through it; and, thirdly, of the ſide-paths and pavements for the driving-way.

The whole external form of the bridge is to be compoſed of Gothic tracery; the railing is alſo to be of Gothic work, with Gothic pinnacles to receive the lamps; ſo that the bridge will, at a diſtance, have the appearance of a frame of light Gothic tracery, finiſhed on the top with that wildneſs of outline of which the Gothic ſtyle is ſo capable.

The abutments, by the ſpreading form of the bridge, their connection with the entrances at each end, and with the wharfs at each ſide of it, will occupy a ſpace on the ſhore ſufficient to form an ample foundation for an edifice capable of reſiſting any preſſure whatever. The form and connection of the maſonry will alſo be calculated to diſtribute the reſiſtance through the whole maſs, in the ſame manner as if it was a ſolid rock of equal magnitude: additional ſtrength will alſo be gained by the land arches, or warehouſes, which are under the inclined planes.

By making three entrances or avenues with the additional width of the bridge at each end, advantages nearly equal to thoſe ariſing from three bridges will be afforded to the public. In all reſpects, therefore, the bridge will be an original deſign, as its important ſituation and diſtinguiſhed name juſtly demand.

The ſcaffolding upon which the iron arch will be turned, is to be formed by driving rows of piles into the river, the top of which will be above low-water mark; theſe piles to be properly braced together; upon them will be raiſed a proper framing to ſupport the part of the iron work which will reſt upon them: at a convenient diſtance, to admit barges to paſs, another ſet of piles and frames will be fixed, and theſe frames will alſo be braced together, at a proper height, over the barge openings, which will admit of gangways being made quite acroſs the river, ſo that the whole will become one general frame from ſhore to ſhore. The top being made to ſuit the curve of the ſoffit of the arch, the iron work will then be fixed upon it with facility and eaſe. The weight of the whole iron work, when diſtributed over ſo great a ſpace, is very ſmall, when compared with works conſtructed with ſtone. The ſcaffolding will not, therefore, re-

quire to be of the large dimenſions which may at firſt be imagined: the truth of the principles was fully proved by the very ingenious, though apparently ſlight, ſcaffolding, over which the arch of Wearmouth was turned; and they may be illuſtrated by ſtating, that the greateſt ſtone arches are turned upon centres formed of timber. When the courſes of ſtone have been brought up to near the crown of the arch, on each ſide, the whole reſts upon the timber centres, and in large arches this weight is very great: the centre muſt, however, be equal to ſupport the weight; otherwiſe it would give way, and the ſtone-work would fall down.

The iron arch is, in fact, no more than a framing ſimilar to that for the centring for a ſtone arch, with this difference, that the iron framing has little more to carry than its own weight. The iron work having much more ſtrength than timber, may be made proportionally ſmaller. In making and putting up timber centres, there muſt be props and ſupports, and the ſcaffolding for ſupporting the iron framing may be compared to theſe props and ſupports.

By deepening and embanking the river, much uſeful ſpace will be gained, and the properties along each bank of the river, as well as the ſtreets adjoining, and leading from thence into the city, will, by a judicious arrangement, be rendered very valuable. Depoſits, and public markets for coals, may alſo be formed under the wharfs, by which means the lighterage of coals brought from the pool up as far as Blackfriars bridge would be completely ſaved. This plan is propoſed by Mr. Douglaſs, who has given a full deſcription of it in the Appendix to the third Report of the Select Committee of the Houſe of Commons. From his eſtimates on the general conſumption of coal in London, it appears, that the ſavings in two years will be adequate to the expenſe of erecting the new iron bridge. This plan merits mature conſideration. The coals being regularly ſupplied, would tend to prevent ſudden injurious competition, which of late years has been ſuch a burthen on the public.

If this part of the plan for improving the port of London be ſucceſsfully executed, we ſhall no longer be reproached by foreigners, that we have one of the fineſt rivers in the world running through our principal city, yet that we ſuffer its uſefulneſs to be in a great meaſure deſtroyed by maintaining a ſtone embankment acroſs the moſt valuable part of it, by ſuffering its ſhores to exhibit an extent of mud, inſtead of converting them into uſeful wharfs; and its banks to be covered with mean and ſhapeleſs buildings, inſtead of edifices ſuited to ſo noble a ſituation, and worthy the commercial metropolis of Europe.

XI. *On the Purification of Rapeseed Oil.* By C. Thenard*.

To purify oil of rapeseed, mix 100 parts of the oil with from 1½ to 2 parts of sulphuric acid, and stir the mixture. The oil will immediately change its colour; it will become turbid and assume a blackish-green tint, and at the end of three quarters of an hour it will be full of flakes. You must then give over stirring it, and add gradually double its weight of water to remove the sulphuric acid, which, if allowed to remain too long with the oil, would not fail to exercise too strong an action on it, and to char it. The mixture must then be beat for at least half an hour, to bring the moleculæ of the oil, the acid, and water, into contact with each other; after which it is to be left at rest.

When it has rested about eight days, the oil will float on the surface of the water, and the latter will itself float on a black matter, precipitated from the oil by the sulphuric acid: it is this matter which colours the oil, and prevents it from burning with facility. Three very distinct strata, then, are established, as is here seen: the upper one is oil; the second is aqueous, and contains a little sulphuric acid; and the third is carbonaceous. The oil which forms the upper stratum, after these eight days of rest, is far from being limpid: twenty days, in my opinion, would be necessary for it to purify itself merely by repose; but by filtration it may be immediately obtained perfectly clear and transparent. For this purpose, pounded charcoal, and a piece of linen or cotton cloth, may be employed: the two last substances are preferable to any other. The same cloth will serve several times, only it must be carefully cleaned.

By following this process with attention, you may obtain oil which has much less colour, odour, and taste, than that commonly used; which will burn with the greatest facility, and without any residuum; and which is equal to the purest oil sold in the shops, &c. The loss is very inconsiderable.

If you are desirous of obtaining it still purer, it may be exposed again to the same treatment; but, in that case, for 100 parts of oil, one hundredth part of concentrated sulphuric acid will be sufficient. The sulphuric acid will not form in oil which has been once purified a blackish precipitate; on the contrary, it produces a very scanty precipitate, of a grayish-white colour. This precipitate is more difficult to be separated than the former.

* From *Journal de Physique*, Floreal, an. 9.

When

When the oil has been treated with two hundredth parts of ſulphuric acid, if it be ſuffered to digeſt for twenty-four hours with the fourth of its weight of chalk or carbonate of lime, or of argil, you will obtain it almoſt as clear as water. Lime, however, cannot be employed with advantage, as it would occaſion too much waſte; but, in my opinion, argil would give very advantageous reſults: it retains, indeed, a pretty large quantity of oil, but, by means of a preſs, the laſt portions of the oil may be extracted from the argil almoſt entirely.

XII. *Reſearches reſpecting the Laws of Affinity.* By C. BERTHOLLET, *Member of the French National Inſtitute.*

[Continued from Vol. IX. p. 352.]

XII. Of Complex Affinities.

1ſt, UNDER the more general name of *complex affinity* I ſhall examine that which has been conſidered as ariſing from the concourſe of four affinities, and which is generally diſtinguiſhed by the name of *double affinity*.

To give an idea of the action of four affinities, Bergman examines what takes place when a ſolution of ſulphate of potaſh and muriate of lime are mixed together. This, ſays he, is as if one ſhould put into the quantity of water employed the proportions of ſulphuric acid, muriatic acid, lime, and potaſh, which enter into the compoſition of theſe ſalts: the two baſes act by their affinities on theſe two acids; but though the affinity of the potaſh for the ſulphuric acid be ſtronger than that which it has for the muriatic acid, the affinity of the muriatic acid for the potaſh, however, added to the affinity of the ſulphuric acid for the lime, gives a ſum of forces greater than the affinity of the ſulphuric acid for the potaſh, and that of the muriatic acid for the lime, which determines an exchange of baſes; ſo that, inſtead of ſulphate of potaſh and muriate of lime, there are produced ſulphate of lime and muriate of potaſh. This explanation is always founded on the ſuppoſition, that the affinities are conſtant forces independently of the quantities and the ſtate of ſaturation.

2d, When the two baſes act conjointly on one acid, the latter divides itſelf, or rather divides its action, in the ratio of their maſſes. Inſtead of one acid there are here two; and if no ſeparation is effected, either by precipitation or cryſtalliſation, the acids

will both act upon the two bases equally in the ratio of their masses: if each of the acids were first combined with a base, after the mixture of the solution of the two salts, the sum of the reciprocal forces of the acids and the alkalies would be the same as before; no muriate of potash or sulphate of lime will be formed, but there will be a combination of potash, lime, sulphuric acid, and muriatic acid, which will give the same degree of saturation as before the mixture. Hence it happens, that when two salts, which, by an exchange, ought to produce combinations which would have very different proportions, are mixed, neither acidity nor alkalicity, which would necessarily show themselves if an exchange took place, are observed, as has been very well remarked by Guyton.

3d, It has been concluded, merely from the result of the precipitation and the crystallisation that has been observed, that an exchange of bases has taken place; but this effect has not been ascribed to its real cause.

We have seen (Art. V.) that the force of cohesion determines the separation which in elective affinities takes place by precipitation or crystallisation: it is the same force also which produces the same effect in complex affinities. When I mix a solution of the sulphate of potash with that of the muriate of lime, and when the quantity of water is not great, the lime, in the contact in which it finds itself with the sulphuric acid (No. 1.) experiences the effect of the force of cohesion in a higher degree than the potash. It is therefore a new force which is added to those which before existed; it must decide the combination of the sulphuric acid with the lime at the time of its precipitation.

4th, If we take a view of all the known decompositions which arise from complex affinities, we shall find that the excess of affinity in opposing affinities is always ascribed to those substances which have the property of forming a precipitate or a salt that may be separated by crystallization; so that, from the degree of the solubility of the salts which can be formed in a liquid, may be predicted the order of the affinities of the substances by which Bergman and other eminent chemists would represent the forces in the symbolical tables; for they always ascribe a superiority of affinities to the two substances which ought to form a combination insoluble in regard to the quantity of the solvent.

Lime, magnesia, barytes, and strontian, form with carbonic acid an insoluble salt; all the soluble combinations of these earths, mixed with alkaline carbonates, produce an exchange, the result of which is the formation and precipitation of carbonates with an earthy base.

Barytes forms with the ſulphuric acid an inſoluble ſalt: when the ſolution of a ſulphate is mixed with that of a ſalt having a baſe of barytes, there is always formed and precipitated a ſalt with a baſe of barytes.

As lime forms a ſulphate very little ſoluble, and which is in a great meaſure precipitated if there be not a great deal of water, it equally changes its baſe with all the ſoluble ſulphates till the period when precipitation ceaſes to take place by the ſolubility of the ſulphate of lime. The ſulphate of lime having ſtill much more ſolubility than ſulphate of barytes, ſalts with a baſe of barytes, which are more ſoluble, decompoſe the ſulphate of lime.

Oxide of ſilver forms an inſoluble ſalt with muriatic acid: all ſalts of ſilver which are ſoluble being mixed with ſoluble muriates, there is precipitated muriate of ſilver. Mercury, if not too much oxidated, has a ſimilar action.

As muriate of lead is little ſoluble, the ſalts which the oxide of lead forms with other acids, and which poſſeſs ſolubility, produce a precipitate with ſoluble muriates; but, as an inſoluble ſalt is made with ſulphuric acid, the ſolution of muriate of lead produces a ſolution of ſulphate of lead when mixed with ſoluble ſulphates.

5th, When water, then, in which different ſalts have been put in ſolution is made to evaporate, theſe ſalts ſeparate according to the order of their ſolubility, and it is by it that one can judge of the changes of baſe which may take place.

But the ſolubility of ſalts varies according to temperatures: it is therefore the relative ſolubility, according to the different temperatures, that muſt be conſidered. The nitrate of potaſh mixed with the muriate of ſoda will cryſtallize at a low temperature, but the muriate of ſoda will ſeparate itſelf even during the time of the evaporation: no exchange of baſes will take place, becauſe the nitrate of ſoda is a little more ſoluble cold than the nitrate of potaſh; and becauſe, on the contrary, the muriate of potaſh is a little more ſoluble warm than muriate of ſoda.

6th, I conſider here only the principal reſult, ariſing from a force of coheſion, of ſuch a nature, that it makes the effect of the forces oppoſed to it to diſappear; but when there does not exiſt a conſiderable coheſion in the combinations which can be formed, the mutual action of the ſubſtances which remain in the liquid ſtate of the ſolvent, and of the proportions which vary by the cryſtallization of the newly-ſeparated combination, muſt produce different effects. The experiments I have begun, will ſoon throw further light on this ſubject.

7th, Another circumstance which may change the action of complex affinities is, the formation of a triple salt which is precipitated; but, by knowing the degree of the solubility of this combination, we may still foresee the composition which must take place. The same consideration may be applied to those affinities called *elective*.

8th, A precipitate is sometimes effected by the mixture of two saline substances which have the same acid; for instance, by a mixture of the muriate of magnesia and the muriate of lime. It is probable that two combinations are then formed, one with an excess of acid and a small part of the two bases, the other with the greatest part of the two bases and a small portion of acid.

This effect is analogous to what we have observed in Art. IX. No. 3; but here it is the mutual affinity of the two bases which determines the precipitation.

9th, We have seen in Art. VII. that heat, by increasing the volatility of a substance, weakens its combination. This cause acts no less in the complex than in the elective affinities. It is a force added to those which act, and determines the union and the separation of those substances which have the greatest tendency to form a volatile combination.

Whenever, therefore, it is desired to know what will happen, by exposing two salts to the action of heat, it is only necessary to examine whether one of the two bases and one of the two acids possess a greater degree of volatility than the remaining base and acid; and we may be assured that, on applying a sufficient degree of heat, the combination of the most volatile base and acid will be formed and sublimed, while the more fixed base and acid will also remain combined. Among the bases, ammonia and the oxide of mercury, and among the acids, the carbonic and muriatic, afford several illustrations of this truth.

10th, Efflorescence ought also to be considered as a force which, in the complex affinities, may determine a combination possessing this property; and to this is owing the formation of natron in the valley of the lake of Natron, and other places where the same circumstances occur.

The observations which I have presented to the Institute of Egypt, which will form a sequel to the interesting discovery of the valley of the lakes of Natron, for which we are indebted to general Andreossi, prove that the circumstances necessary to the formation of natron are, 1. A sand, which contains much carbonate of lime; 2. Moisture; and, 3. The presence of the muriate of soda: I have also remarked, that the stalks of the reed, in a great degree, facilitate the production

tion of this ſubſtance. I have promiſed to explain the formation of the carbonate of ſoda by means of theſe circumſtances, which I ſhall now endeavour to perform.

Calcareous ſand, conſtantly impregnated with moiſture, may be conſidered as a ſolution of the muriate of ſoda, which acts upon the carbonate of lime. Now it follows, from what has been explained in Art. IV. that inſolubility cauſes a great diminution in the mutual action of a ſolid and a liquid ſubſtance, but that it does not deſtroy it. This action is oppoſed to the inſolubility of the carbonate of lime, which is not abſolute. A ſolution muſt therefore be formed of a ſmall quantity of carbonate of lime, and, conſequently, (No. 1 and 2,) the conſtituent parts of this carbonate and of the muriate of ſoda, which are in ſolution, exert a reciprocal action; otherwiſe the preſence of the carbonate of lime would not be a condition neceſſary to the formation of the carbonate of ſoda*.

We muſt, therefore, conſider the humidity of the calcareous ſand, in which the carbonate of ſoda is formed, as a ſolution of muriate of ſoda and a ſmall quantity of carbonate of lime: hence ſoda and carbonic acid are both preſent, and the efflorеſcence, which is a property of the carbonate of ſoda, ought to be conſidered as a new force that tends to remove it from this combination. In ſhort, when, in a ſoil impregnated with muriate of ſoda, we meet with the ſtalks of reeds which favour the efflorеſcence, the carbonate of ſoda not only accumulates round theſe ſtalks, but ſometimes it is not formed without ſuch aſſiſtance, when certain circumſtances, ſuch as a too argillaceous nature of the ſoil, &c. are little favourable to its production; ſo that at a ſhort depth muriate of ſoda only is diſcoverable.

* The ſolution of the carbonate of lime by the muriate of potaſh and by the ſulphate of potaſh, which indubitably act like the muriate of ſoda, has been proved by a direct experiment, for which we are indebted to Guyton. (*Mem. de Scheele*, part ii. note de la page 18.) "The ſolution of ſulphate of potaſh, muriate of potaſh, &c. poured in lime-water which has been rendered milky by water impregnated with carbonic acid gas, immediately cauſed the precipitate to diſappear. There was likewiſe no earthy precipitate when water, charged with carbonic acid gas, was poured in a mixture of lime-water and a ſolution of theſe neutral ſalts; the liquor always contained a portion of uncombined alkali." Guyton combats the opinion of Scheele, who did not obſerve any decompoſition with the muriate and ſulphate with baſe of potaſh, but only with the ſalts with baſe of ſoda.

The difference of opinion between thoſe celebrated chemiſts aroſe from the circumſtance, that one aſcertained the decompoſition only by the efflorеſcence, which is peculiar to ſalts with baſe of ſoda (Art. VIII.), while the other obſerved it in a liquid, but in the latter inſtance it is much more limited.—B.

I wiſhed to aſcertain the truth of this explanation in a trough placed in one of the gardens belonging to the Inſtitute. For this purpoſe, ſome carbonate of lime and ſiliceous earth, both well waſhed, were mixed together, to which was added a certain proportion of muriate of ſoda: a hole was made in this mixture, for the purpoſe of pouring in water occaſionally, and keeping up the neceſſary degree of moiſture. An incruſtation of muriate of ſoda is formed at the ſurface, which already ſtrongly changes the colour of paper tinged with brazil wood, like the alkalis; but we cannot expect to obtain an efflorescence ſo conſiderable as to be perceptible to the ſight, till after a much greater length of time.

11th, The preceding obſervations ſhow that the only difference which diſtinguiſhes the complex affinities from thoſe called *elective*, is, that in the former, ſubſtances are brought into action which are nearly in an uniform degree of ſaturation; and that, in the latter, there is a ſubſtance preſent which is not yet ſaturated (or ſeveral ſuch ſubſtances may be preſent); ſo that, in the former, a new degree of ſaturation is eſtabliſhed only in proportion to the combinations which are capable of being ſeparated; whereas, in the latter, the action of the unſaturated ſubſtances becomes in equilibrio with that of the ſubſtances which were already ſo; whence it happens that the force of coheſion and that of elaſticity produce their effect more completely in the complex than in the elective affinities.

XIII. *Some Account of the Life of the celebrated Mathematician* BOSCOVICH.

ROGER JOSEPH BOSCOVICH was born at Raguſa, in Dalmatia, on the 18th of May 1711. It is aſſerted in the *Gazette de France* for 1775, that his mother lived to the great age of one hundred and two. His ſiſter, alſo, is ſaid to have attained to a great age, and to have been much eſteemed for her poems, written in the Italian language. Boſcovich entered into the order of the jeſuits on the 1ſt of October 1725; in November 1740 he was appointed profeſſor of mathematics in the Roman college, and diſtinguiſhed himſelf by ſeveral excellent mathematical and aſtronomical diſſertations on the rotation of the ſun, on the inequalities in the motion of Jupiter and Saturn, on light, on dioptrics, on the tides, on the atmoſphere of the moon, and the method of calculating the orbits of comets. In the year 1750 he was employed by cardinal Valenti, miniſter of ſtate to

pope

pope Benedict XIV. to measure a degree of the meridian in the territories of the church; an undertaking which he accomplished in a satisfactory manner, in conjunction with father Maire of the same order, and of which he gave an account in a work published at Rome in 1755 under the title of *De Literaria Expeditione per Pontificiam Ditionem*, &c. This work was afterwards translated into French, and published at Paris, with the title of *Voyage Astronomique et Géographique dans l'Etat de l'Eglise*, &c.

The measuring of a degree of the meridian in Austria and Hungary by F. Liesganig, in Piedmont by F. Beccaria, and in America by Mason and Dixon, were undertaken on the suggestion of Boscovich, and by means of the influence which he had in different courts on account of the great reputation he had acquired in the mathematics: on the same account he was chosen by the Royal Society of London to observe the second transit of Venus in California; but the dissolution of his order, which happened about that time, prevented his acceptance of this appointment.

In the year 1759 he published at Vienna his *Philosophiæ naturalis Theoria*, and in 1763 he was invited to be professor of the mathematics at Pavia, where he taught for six years. He afterwards removed to Milan, on an invitation from the imperial minister count Firmian, to be professor of astronomy and optics; and while in this situation he founded the observatory of the jesuits in that city, which gave rise to the imperial observatory, and that now called the Cisalpine observatory of Brera.

In the year 1773, on the destruction of the order of the jesuits, Boscovich was invited to France by his friends in that country, among whom were De la Borde, Durfort, the ministers Boynes and Vergennes, and madame de Sivrac. On this occasion he was naturalised, and obtained the appointment of *directeur d'optique et de la marine*, with an annual salary of 8000 livres.

Boscovich was a poet of no inconsiderable merit; for the dry and abstruse study of the mathematics damped neither the fire of his genius nor destroyed those powers of the imagination by which those born poets are peculiarly distinguished. His Latin poem on eclipses is highly worthy of notice, both on account of its internal poetical merit, and of the ability and clearness with which the author gives precepts for the most difficult calculations, and explains the most complex parts of the theory of astronomy. It has been translated into French by Barruel. The esteem in which Boscovich was held, occasioned his being involved also in political

nego-

negotiations. The republic of Lucca entruſted him with the defence of its intereſts in regard to its waters and boundaries, then under diſcuſſion with the deputies of Tuſcany; and he was ſent to Vienna to defend this cauſe before the emperor. This buſineſs he brought to a happy concluſion, and thereby rendered an eſſential ſervice to the republic. He travelled a great deal, and viſited moſt parts of Europe, and even Turkey. His Tour to Conſtantinople went through two editions, one in Italian in 1762, and a German tranſlation in 1772.

So much merit did not remain free from thoſe animoſities which are generally excited by great talents. Some circumſtances which took place at Paris on the part of ſome of the literati of that capital, gave him conſiderable uneaſineſs; and, as he poſſeſſed great ſenſibility, they made a greater impreſſion on his mind than they perhaps ought to have done. On this account he reſolved, in 1783, to leave Paris, and to proceed to Italy, in order to collect and publiſh his whole works, which appeared at Beſſano in 1786, though ſaid to be printed at Straſburgh, in five quarto volumes, under the title of *Opera ad Opticam et Aſtronomiam pertinentia*. The part relating to nautical aſtronomy was tranſlated into German, and publiſhed ſeparately at Leipſic, in 1787, by Eſchenbach. He wrote alſo the principles of the mathematics and philoſophy, together with a treatiſe on teleſcopes, which F. Charles Scherfer tranſlated into German and publiſhed at Vienna, in 1765.

In the year 1786 he went to Milan, and was employed by the emperor Joſeph to ſuperintend the meaſuring of a degree of the meridian and the conſtruction of a map of Lombardy; but a fit of apoplexy, with which he was ſeized on the 12th of February, put a period to his exiſtence in the 76th year of his age.

Boſcovich was a man much beloved in ſociety; his converſation was animated and agreeable, and his facility for poetical compoſition was ſuch, that he could readily dictate verſes in the courſe of converſation with his friends. To the variety, the ſtrength, and the cultivation of his talents, he added the moſt reſpectable moral principles, and a deportment which rendered the attachment of his friends no leſs lively than their eſteem and reſpect. Before we conclude this article it deſerves to be remarked, that ſeveral men of great mathematical genius have been born on the eaſtern coaſt of the Adriatic: Boſcovich, Paſquich, Vega, Cagnoli, and Bogdanich, were natives of Dalmatia, Carinthia, Albania, and Croatia, &c. all excellent mathematicians.

XIV. *Account*

XIV. *Account of the Discovery of Silver in Herland Copper Mine.* By the Rev. MALACHY HITCHINS*.

HERLAND Mine is situated in the parish of Gwinear, about seven miles north-east of St. Michael's Mount, on the southern coast of Cornwall; and two miles and a half from the mouth of the river Hayle, on the northern coast of the same county; it is contiguous to Prince George mine.

It commences in a valley on the west, and passes through a hill, which is first of steep, and then of moderate, ascent, for upwards of half a mile eastward; when the principal copper lodes, which follow this direction, meet with a large cross lode, by which, and by other cross courses and flookans, which intersect them in their farther progress, they are repeatedly heaved, and so disordered by these heaves, in their form and position, and so changed by them, in respect to their composition, as hardly to be recognized.

The strata of the district in which this takes place, consist of the common metalliferous sort of argillaceous slate called *killas*.

The copper lodes of this district are remarkable for the shortness of their continuity; for, whereas other lodes may be traced to an indefinite extent in the same line of direction, these, on the contrary, are observed to taper away gradually, and terminate, to all appearance, at a short distance, completely and irrecoverably.

This mine was worked about twenty years ago, when it was sunk to the depth of one hundred fathoms from the surface. It was again set to work about eight years since; has now four fire-engines and two steam-whims on it; and is sunk to a depth of one hundred and fifty-five fathoms below the surface, or, as the miners call it, from *grass*.

It is in this latter period of its history, that a discovery has been made of a considerable quantity of silver ore, in a particular part of the mine, the singularity of which discovery, in this country, has much excited the curiosity of the public.

For, although the numerous veins of lead in Cornwall are richly impregnated with silver, and occasionally yield small quantities of silver ores, and even specimens of native silver, yet, hitherto, no instance had been known of their yielding this precious metal in such abundance; nor had any circumstances, in the natural history of the mineral veins of this

* From the *Transactions of the Royal Society for* 1801.

country,

country, borne any analogy to thoſe which accompanied the preſent diſcovery.

Theſe circumſtances, therefore, having been examined with more attention than uſual, ſhall be ſtated with as much preciſion as it is poſſible to obtain, from the report of thoſe practical miners only who have hitherto inſpected them.

The facts which deſerve to be firſt noticed are, the confined and inſulated poſition of the maſs of ſilver ore; its great depth from the ſurface of the mine; and its contiguity to a copper lode.

The lode in which it occurs is one of thoſe croſs courſes, as they are here called, which interſect and derange the copper lodes, and conſequently are of a more recent formation.

Lodes in this direction are uſually filled with quartz, but frequently produce galena; and ſometimes, inſtead of galena, ſulphurated antimony. They appear here to conform to the ſame laws, except in the particular inſtance now to be deſcribed, which forms, indeed, a very remarkable exception.

No ores of ſilver were obſervable in this lode until at the depth of one hundred and ten fathoms from the ſurface, or eighty below the adit or level; and, at the farther depth of thirty-two fathoms, they diſappeared.

They have been diſcovered only in the neighbourhood of one of the interſected copper lodes, extending no where above twelve feet from this lode, on the north, or above thirty-two feet from it on the ſouth, and acquiring this their greateſt extent at the deepeſt level; for the uſual dimenſions of the ſilver ore are not more than ſix feet in the former ſituation, and twelve feet in the latter.

It is remarkable that, at the point of contact or interſection, the contents of the ſilver lode are ſo poor as to be ſcarcely worth ſaving; and thoſe of the copper lode are much leſs productive of copper than at a little diſtance from this point. Moreover, that the copper lode, in the vicinity of the interſection, ſeems to have been influenced by the ſame cauſes of improvement and declenſion as the croſs lode; being richer or poorer in copper, as the latter was, at a correſpondent level, in ſilver.

The richeſt maſs of ſilver ore was found at the depth of two fathoms above the level at which it diſappears.

After this brief account of the moſt ſtriking facts, it may be proper to enter into a more particular deſcription of the two lodes which appear, by their interſection, to have generated this body of extraneous matter.

The copper lode bears nearly eaſt and weſt by the compaſs;

paſs; the croſs lode nearly north and ſouth, or at right angles to it.

The former is about two feet broad, on an average; and it dips or underlies ſouth, one foot in a fathom. The breadth of the latter is about two feet and a half, on an average; and its underlie is eaſt, about eight inches in a fathom.

The heave of the copper lode is about eighteen or twenty inches to the right, in the language of the Corniſh miner; the expreſſion being ſo far appropriate and convenient, as it refers to the uſual ſituation of the obſerver in the heaved lode.

The copper lode is filled with layers of ore and ſtony matter, the latter of which is here called *caple*; but the ore is uſually found contiguous to the walls of the lode.

The contents of the croſs lode are more ſingular, in reſpect to their local poſition, and more various. Only the eaſtern ſide of it produces ſilver ore, the breadth of which is in general about ſix or eight inches, although in ſome places it is greater. The other part of the lode is chiefly compoſed of quartz, intermixed with iron, manganeſe, and wolfram, together with a ſmall portion of cobalt and antimony.

The ſilver ore, ſtrictly ſpeaking, is a mixture of galena, native biſmuth, gray cobalt ore, vitreous ſilver ore, and native ſilver; which, in reſpect to their proportions, follow the order in which they are here enumerated, the galena being the moſt prevalent. The native ſilver, of which ſpecimens of the greateſt beauty have been reſerved for the cabinets of the curious, is found chiefly in a capillary form, in the natural cavities of the lode.

About one hundred and eight tons of this ore have been raiſed. The miners continue to ſink near the ſame point of interſection; and ſeem confident that both lodes will ſoon become richer, becauſe ſimilar inſtances of declenſion and recovery have frequently occurred in the copper lodes of this mine, and becauſe the two lodes appear to have a reciprocal influence on each other.

Unfortunately, however, the extent of their ſpeculation is limited by the great depth of the preſent workings; for, forty-five fathoms have been ſunk ſince the firſt diſcovery of the ſilver; and twenty, or twenty-five fathoms more, are as much as can be ſunk in this mine, with its preſent mechanical powers of drawing the water; at which level, viz. one hundred and eighty fathoms from the ſurface, it would be ſomewhat deeper than any mine in Cornwall, and about one hundred and thirty fathoms below the level of the ſea at low-water mark.

The other croſs lodes in this mine produce no ſilver; moſt

of

of them being flookans, or lodes which are eſſentially different from the argentiferous croſs lode, in the nature of their conſtituent maſs. There is one, however, in the eaſtern part of the mine, which, from its reſemblance to that, is thought likely to produce ſilver, whenever it ſhall be explored to the ſame depth, at its point of interſection; although theſe hopes may probably be fallacious, for the argentiferous lode interſects five other copper lodes, viz. two on the north, and three on the ſouth ſide, without producing any ſilver.

XV. *Account of New Publications.*

I. *Philoſophical Tranſactions of the Royal Society of London for the Year* 1801. *Part I.*

THIS Part contains:—1. The Croonian Lecture: On the Irritability of Nerves. By Everard Home, Eſq. F.R.S.—2. The Bakerian Lecture: On the Mechaniſm of the Eye: By Thomas Young, M.D. F.R.S.—3. On the neceſſary Truth of certain Concluſions obtained by means of imaginary Quantities. By Robert Woodhouſe, A.M. Fellow of Caius College.—4. On the Production of artificial Cold by Means of Muriate of Lime. By Mr. Richard Walker.—5. Account of a monſtrous Lamb. In a Letter from Mr. Anthony Carliſle to the Right Hon. Sir Joſeph Banks, Bart. K.B. P.R.S.—6. An anatomical Deſcription of a male Rhinoceros. By Mr. H. Leigh Thomas, Surgeon.—7. Demonſtration of a Theorem, by which ſuch Portions of the Solidity of a Sphere are aſſigned as admit an algebraic Expreſſion. By Robert Woodhouſe, A.M. Fellow of Caius College, Cambridge.—8. Account of the Diſcovery of Silver in Herland Copper Mine. By the Rev. Malachy Hitchins.—Account of an Elephant's Tuſk, in which the Iron Head of a Spear was found imbedded. By Mr. Charles Combe. In a Letter to the Right Hon. Sir Joſeph Banks, Bart. K.B. P.R.S.—10. Deſcription of the Arſeniates of Copper and of Iron from the County of Cornwall. By the Count de Bournon.—11. Analyſis of the Arſeniates of Copper and of Iron, deſcribed in the preceding Paper; likewiſe an Analyſis of the red octaedral Copper Ore of Cornwall; with Remarks on ſome particular Modes of Analyſis. By Richard Chenevix, Eſq. M.R.I.A.—Appendix.—Meteorological Journal kept at the Apartments of the Royal Society, by Order of the Preſident and Council.

II. *Journals*

II. *Journals of the Royal Inſtitution of Great Britain. Numbers 2 and 3.*

Each ſheet of theſe journals is counted as one Number, price ſixpence. The contents of No. 2 and 3 are:—1. A Report on the Progreſs which has been made in the Arrangement of the Royal Inſtitution, its preſent State, and its probable future Proſperity and Utility.—2. Obſervations relative to the Means of increaſing the Quantities of Heat obtained in the Combuſtion of Fuel. By Count Rumford.—3. On the Uſe of Steam as a Vehicle for conveying Heat from one Place to another. By Count Rumford.—4. An Account of a new Eudiometer. By Mr. Davy.

The three laſt-mentioned articles will be found copied into the preceding pages of our preſent Number.

III. *An Epitome of Chemiſtry.* By William Henry. *Small* 12*mo.* Johnſon, St. Paul's Church-Yard.

[Concluded from Vol. IX. p. 268.]

Though we have already laid before our readers a pretty ample extract from this uſeful little volume, we believe they will not be diſpleaſed by a further one. Among the rules for aſcertaining the purity of chemical preparations are the following:

"*Sulphuric Acid—Acidum Vitriolicum of the London Pharmacopœia.—Oil of Vitriol.*

"The ſpecific gravity of ſulphuric acid ſhould be 1850. It ſhould remain perfectly tranſparent, when diluted with diſtilled water. If a ſediment ſhould occur, on dilution, it is a proof of the preſence of ſulphate of lead or lime.

"Iron will be detected in ſulphuric acid by ſaturating a diluted portion of it with pure carbonate of ſoda, and adding pruſſiate of potaſh, which will manifeſt the preſence of iron by a pruſſian blue precipitate. Copper may be diſcovered by pouring, into a ſimilar ſaturated ſolution, pure ſolution of ammonia; and lead may be detected by the ſulphuret of ammonia. The latter metal, however, is generally precipitated, on dilution, in combination with ſulphuric acid.

"Sulphate of potaſh or of ſoda may be found by ſaturating the diluted acid with ammonia, evaporating to dryneſs, and applying a pretty ſtrong heat. The ſulphate of ammonia will eſcape, and that of potaſh or of ſoda will remain, and may be diſtinguiſhed by its ſolubility and other characters.

"*Nitric and Nitrous Acids—Acidum Nitrosum, Pharm. Lond. Aquafortis.*

"The nitric acid should be perfectly colourless and as limpid as water. It should be preserved in a dark place, to prevent its conversion into the nitrous kind.

"These acids are most likely to be adulterated with sulphuric and muriatic acids. The sulphuric acid may be discovered by adding to a portion of the acid, largely diluted, nitrated or muriated barytes, which occasion, with sulphuric acid, a white and insoluble precipitate. The muriatic acid may be ascertained by nitrate of silver, which affords a sediment at first white, but which becomes coloured by exposure to the direct light of the sun. Both these acids, however, may be present at once; and, in this case, it will be necessary to add a solution of nitrate of barytes as long as any precipitate falls, which will separate the sulphuric acid. Let the sediment subside; decant the clear liquor, and add the nitrate of silver. If a precipitate appear, muriatic acid may be inferred to be present also.

"These acids should have the specific gravity of 1550.

"*Muriatic Acid—Acidum Muriaticum, P. L. Spirit of Salt.*

"This acid generally contains iron, which may be known by its yellow colour, the pure acid being perfectly colourless. It may also be detected by the same mode as was recommended in examining sulphuric acid.

"Sulphuric acid is discoverable by a precipitation on adding the muriate of barytes.

"The specific gravity of this acid should be 1170."

IV. *Analytical Essays towards promoting the Chemical Knowledge of Mineral Substances. By* Martin Henry Klaproth, *Professor of Chemistry, Assessor to the Royal College of Physicians, Member of the Royal Academy of Sciences at Berlin, and various other learned Societies. Translated from the German.* 1 *Vol.* 8vo. p. 592. *London: Cadell and Davies.*

THE merits of Klaproth as an analyser are too well known to require commendation. The learned translator, Doctor Gruber, could not have rendered a more acceptable service to English chemists than by giving them the present translation, which is faithful and accurate. We subjoin a short extract from the work.

Chemical

Chemical Examination of the Elaſtic Quarz, (Sand-Shiefer, flexible Sand-ſtone,) from Brazil.*

The ſingular elaſtic flexibility, ſo ſeldom occurring in the mineral kingdom, in which this foſſil, in its form and appearance, reſembles novaculite (Turkey hone), has attracted the attention of naturaliſts, but at the ſame time has led many perſons to doubt its exiſtence as a natural ſubſtance, and to ſuſpect that this may probably be a product of art. It comes from Brazil, near Villa-rica, the principal town of the province of Minas Geraës, which fact was, for a while, kept a ſecret. There it occurs in not very thick ſtrata, whoſe hanging and ſhading ſides are caſed over by a gray cruſt of $\frac{1}{2}$ inch thick; and from thence it was brought to Portugal the firſt time, in the year 1780, by the marquis de Lavradio, viceroy at Rio de Janeiro. Among the ſpecimens I have ſeen, that of the imperial cabinet at Vienna, ſo remarkable for its precious foſſils, is by far the greateſt; it being 26 Vienna inches long, 16 inches broad, and 1 inch thick. It is, however, probable that this ſtone, together with its remarkable phyſical property mentioned before, was already known in the ſixteenth century; and that it is the ſame with that deſcribed by Gaſſendi, *in Vita Peireſkii* †, in the character of a flexible whetſtone (novaculite); as ſuggeſted by the authors of the *Göttingiſche Gelehrte Anzeigen*, when this ſtone has again been brought into notice ‡.

On inſpecting with a microſcope the homogeneous or integrant parts of which this elaſtic ſtone is aggregated, and which may be eaſily ſeparated by compreſſure or levigation, I found them all alike; that is, they were all flat, longiſh plates or ſcales, perfectly clear and pellucid. All their difference conſiſted in the variety of their outlines; ſome truncated more ſharply, others more obtuſely; others longer, but very thin; while others were broader and ſhorter; but moſt of them I perceived on one or both ſides notably ſinuated. I am inclined to think, that the elaſticity of this foſſil originates ſolely from the form of its aggregation. For, as may be diſtinctly ſeen at the firſt glance in the entire ſtone,

* Schriften der Berliner Geſellſchaft Naturforſchender Freunde, b. vi. 1785, p. 322.—The miners indicate by theſe expreſſions the greater or leſs ſlope in the ſtrata, though chiefly with reference to rake-veins, not fully perpendicular. The hanging ſide is that toward the day, and is alſo called *hanger*; and the hading ſide, which likewiſe goes by the name *ledger*, is the under one next to the bed of the ſtratum. See *Williams's Natural Hiſtory of the Mineral Kingdom*, 8vo. Edinb. 1789: vol. i. p. 269. Tranſl.

† Libr. iv. ad annum 1630. p. 254. edit. 1706.

‡ Of the year 1784, No. 211.

all thoſe longiſh lamellæ are interwoven in one ſingle direction, and implicated in ſuch a manner, that each junction reſembles a vertebra, or hinge. With this idea, alſo, correſponds the particular kind of the flexibility of the ſtone, which is not tough or coriaceous. For, if the ſtone be held upright and ſhaken, it vibrates with ſome noiſe to and fro; but as ſoon as its agitation is diſcontinued, its parts conjoin again firmly by a force like a ſpring.

I now proceed to its chemical analyſis.

As, on triturating, I found the particles of the ſtone extremely hard, which was indeed previouſly aſcertained by its faculty of cutting glaſs with eaſe, and of ſtriking fire with ſteel, I endeavoured to facilitate its decompoſition by previous mechanical comminution.

To effect this, I ſubjected one hundred grains to red heat, and quenched them in cold water; but I obſerved, that by this, neither their weight nor their hardneſs had decreaſed. They were then reduced to an impalpable powder in an agate mortar, mixed with four parts of dried carbonated ſoda, and ignited under the muffle in a porcelain ſaucer, during ſix hours, in a moderate degree of heat; by which the mixture only conglutinated, without actual fuſion. The ignited maſs was pulverized with water, ſuperſaturated with muriatic acid, digeſted and filtered. A quantity of very looſe ſiliceous earth, to the weight of 96½ grains, remained on the filter.

The ſeparated muriatic fluid was treated with Pruſſian alkali; and the blue precipitate, thence ariſing, ignited. It weighed one grain; of which, however, only ½ grain can be reckoned as oxide of iron, entering into the 100 grains of the decompoſed foſſil.

At laſt, by ſaturating the ſolution with carbonated potaſh, a tender earth was thrown down; which, after waſhing, drying, and ignition, weighed 2½ grains; and, examined by means of ſulphuric acid, was found to be aluminous earth.

Conſequently, hundred parts of elaſtic quarz from Brazil have yielded,

Silex - -	96,50
Alumine -	2,50
Oxide of iron -	0,50
	99,50

There are ſometimes very ſmall blackiſh grains, like points, mingled with this ſtone. As theſe probably are garnets, or cryſtals of horne-blende, it ſeems that the portion of iron and alumine diſcovered in the foſſil chiefly proceeds from them.

XVI. *Pro-*

XVI. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

THERE was no meeting on the laſt Thurſday in May, on account of Whitſun week.

On the 4th of June a deſcription of a new aſtronomical inſtrument was read; as was alſo a meteorological journal, kept at Clifton, near Briſtol.

June 11. An account of a method of preparing, in the humid way, a ſimilar ſubſtance to James's powders. By Richard Chenevix, Eſq.

Alſo an account, by Mr. Ware, of the removal of cataracts from the eyes of a boy who had been blind from his infancy; with a detail of the child's obſervations on firſt beholding forms.

June 18. A curious and highly intereſting paper on galvaniſm, by Mr. Davy, containing an account of ſome galvanic combinations formed by the arrangement of ſingle metallic plates with different ſtrata of fluids analogous to the pile of ſignor Volta. All theſe combinations are formed by the arrangement of different chemical agents with ſingle metallic plates. The moſt powerful claſs may be formed by arranging plates of copper or ſilver, and cloths moiſtened, ſome in nitrous acid, ſome in ſolution of ſulphuret of potaſh, and ſome in ſolution of ſulphate of potaſh, in the following order: metallic plate, acid, ſolution of ſulphate of potaſh, ſolution of ſulphuret of potaſh;—then, if the ſpecific gravities of the fluids are in the order of their arrangement, *i. e.* that of the acid greateſt, and that of the ſolution of ſulphuret leaſt, but little mixture or chemical action between them will take place. Twelve plates of copper arranged in this way give ſenſible ſhocks, and rapidly produce the common appearances in water. In all the galvanic combinations with ſingle plates, the metallic ſurface which oxidates is the ſurface which in the circuit with wires produces hydrogen from water.

On the ſame evening were read ſome additions, by Dr. Hulme, to his paper of laſt year, on the ſpontaneous light emitted by various bodies. Some very curious experiments were detailed reſpecting the immerſion of the luminous bodies in the different gaſes, and the effects thereby produced upon them.

On the 25th there was read a highly intereſting paper on the identity of the galvanic and electric fluids, by Dr. Woollaſton. The doctor has ſucceeded in decompoſing water by means of common electricity, as rapidly as by the pile of

Volta. He has obviated the difficulty which occurred from the fluid paſſing more or leſs in the form of ſparks, by employing a gold and a ſilver wire, inſulated in oppoſite ends of a glaſs tube, and preſenting to each other as fine a point as they could poſſibly be made to take. The tube in which they were inſerted contained the water to be decompoſed, and made part of an electric circuit.

Some valuable additions to Mr. Aſhley Cooper's paper on the membrana tympani were read the ſame evening, giving an account of ſeveral caſes of perſons being reſtored to hearing by this membrane being ſimply punctured.

ROYAL INSTITUTION OF GREAT BRITAIN.

Since our laſt notice, a ſhort courſe of lectures on pneumatic chemiſtry have been delivered by Mr. Davy. They were extremely ingenious, and excited a conſiderable degree of intereſt. The concluding lecture was on the 20th of June, on reſpiration; and after the lecture an opportunity was given to ſuch as wiſhed it, to breathe ſome of the nitrous oxide, the gas of which we gave ſo full an account in our ſixth volume under the name of *gaſeous oxide of azote*.

Mr. Groſvenor Bedford, Mr. Stodart, and Mr. Underwood, breathed the gas; and the effects it produced, eſpecially on the laſt, were truly wonderful. He experienced ſo much pleaſure from breathing it, that he loſt all ſenſe to every thing elſe, and the breathing-bag could only be taken from him at laſt by force. The irreſiſtible tendency to muſcular action produced by this gas was ſuch as cannot be deſcribed; it muſt be witneſſed to be conceived.

Profeſſor Pictet, of Geneva, who is now on a viſit in this country, count Rumford, and other philoſophers of eminence were preſent, and ſeemed not a little gratified with the exhibition of this gas.

On the 23d of June a ſelect party met at the Inſtitution to try the effects of the gaſeous oxide. Count Rumford, Sir Charles Blagden, Dr. Woolaſton, Profeſſor Pictet, and other ſcientific gentlemen were preſent. Several of them breathed the gas, and were more or leſs affected with pleaſurable ſenſations and other effects uſually produced by the inhalation of this gas.

Another galvanic courſe was alſo given by Mr. Davy, which, being delivered in the fore part of the day, was attended not only by men of ſcience but by numbers of people of rank and faſhion; a proof that this Inſtitution bids fair to promote a taſte for philoſophical purſuits among thoſe whoſe wealth

wealth has but too often foſtered the idea that ſuch ſubjects were beneath the notice of *independence*. The ſubſtance of theſe lectures will, we underſtand, be publiſhed in the journals of the Royal Inſtitution.

We are ſorry to ſtate that the Inſtitution has loſt the future ſervices of Dr. Garnett, that gentleman having given in his reſignation within theſe few days to the managers. His reaſons for withdrawing we have not heard; we are happy, however, to learn that his medical abilities will ſtill be devoted to the ſervice of the public.

SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES, AND COMMERCE.

This uſeful body, to whom the public are indebted for numerous improvements which, moſt probably, would never have been introduced but for the emulation it excites among all ranks, and the liberal patronage it affords to every thing calculated to benefit the community, had its annual meeting for the diſtribution of premiums and honorary rewards, at the Society's rooms in the Adelphi, on the 26th of May.

A conciſe but intereſting hiſtory of the Society, embracing an account of its origin and progreſſive advancement, and aſſerting with proper confidence, yet with becoming modeſty, the ſervices it has rendered to the arts, manufactures, and commerce of the country, was read by Mr. Taylor, the ſecretary; after which the names of the ſucceſsful candidates were proclaimed, and the rewards of the Society delivered to them by the hands of the chairman, accompanied with the hearty gratulations of a numerous and highly reſpectable meeting.

FRENCH NATIONAL INSTITUTE.

A commiſſion appointed by this body has lately been occupied with experiments in galvaniſm, on which ſubject the following notice was read by C. Cuvier:

Accident, the parent of almoſt all diſcoveries, has lately favoured the philoſophical world in a manner which will render this epoch very remarkable in the hiſtory of the ſciences. Some bits of metal brought into contact have manifeſted phænomena which no ſagacity could foreſee, and have opened to us a field as vaſt as it is fertile in important applications.

The influence of theſe phænomena becomes more and more extended. Being at firſt confined, according to every appearance, to the animal œconomy, it ſeems now to act an important part in chemiſtry. It is to the genius of Volta,

above all, that we are indebted for this new diſcovery. His opinion, that galvaniſm was only an application of electricity to the animal œconomy, having been confirmed by ſeveral men of ſcience, he endeavoured to find out the means of increaſing its effects ſo far as to render the real nature of them evident to every body; and he found that, by multiplying the pairs of metals, diſpoſing them always alternately, and keeping them moiſt—attractions, repulſions, and commotions, perfectly ſimilar to thoſe occaſioned by the Leyden flaſk, are produced; and that, in general, a pile, formed of ſilver, zinc, and moiſtened paſteboard alternately, immediately manifeſts all the appearances of vitreous electricity at the extremity where the ſilver is, and of the reſinous at that where the zinc is placed. There is, however, this difference, that a Leyden flaſk, once diſcharged, exhibits no more effects unleſs it has been again charged; whereas Volta's pile conſtantly charges itſelf ſo that its effects are inceſſantly renewed; and it is only by diſcharging it with very large conductors that it can be diminiſhed for a moment.

Beſides, the Leyden jar will always diſcharge itſelf by the means of water. If there be the leaſt moiſture in continuity between its two ſurfaces, its effects are annihilated; but with however much water the paſteboard-pieces of Volta's pile may be impregnated, its effects loſe none of their intenſity: they do not ceaſe till the pile is entirely immerſed in water.

Theſe differences ought to excite ſome doubts reſpecting the perfect identity of galvaniſm with electricity; and other phænomena, ſtill more extraordinary, increaſe theſe doubts. If the ends of two metallic wires be immerſed in water, one of which communicates with the reſinous or negative extremity of the pile, and the other with the vitreous or poſitive; and if they be kept at a little diſtance from each other, there are diſengaged from the extremity of the former bubbles of hydrogen gas, and from that of the other oxygen gas, which becomes fixed in the metal when the latter is oxidable, or, if it be not ſo, riſes in bubbles; and this action continues as long as the apparatus remains in this ſtate. But it is not in this that the great ſingularity of the phænomena conſiſts, and it is here that galvaniſm begins to enter the province of chemiſtry.

It would have been very natural to conſider this gas as the product of the decompoſition of water, if a particular circumſtance had not excited doubts in regard to this explanation. That the diſengagement may take place, the ends of the wires muſt be at a certain diſtance; if they touch, no bubbles are ſeen. How comes it that the oxygen and hydrogen, ariſing

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from the ſame molecule of water, ſhould appear at points ſo far diſtant? And why does each of them appear excluſively at the wire connected with one of the extremities of the pile, and never at the other?

Such was the ſtate of our knowledge reſpecting galvaniſm at the time of the notice given to the claſs three months ago. All the experiments made in France and other countries, arranged and confirmed by a commiſſion, have conducted to the three following reſults:—an augmentation of intenſity, according to the number and extent of the metallic ſurfaces brought into contact; a continued renewal of the action; and a production of the two gaſes by the communication of the two extremities of the pile with water.

But for three months paſt philoſophers have redoubled their efforts; their curioſity has been excited, above all, by the laſt phænomenon: ſome have imagined they could diſtinguiſh in it the baſes of a new ſyſtem of chemiſtry; others, more prudent, have ſuſpended their judgment, or have endeavoured to refer the facts to the theories already known. But, whatever might be their individual ſyſtem, they ought all to have begun by a ſimilar reſearch—by trying to produce the two gaſes in ſeparate quantities of water.

If the two quantities of water are perfectly inſulated, the gas does not appear: if they are made to communicate by a metallic wire, there is only a double production of gas; that is to ſay, each extremity of the intermediate wire acts in the portion of water in which it is immerſed, as if the wire came immediately from the extremity of the pile oppoſed to that which communicates with that portion, ſo that each portion gives at the ſame time two gaſes.

But if ſulphuric acid be interpoſed between the two quantities of water, the gaſes manifeſt themſelves each on its own ſide. The caſe is the ſame if a communication be eſtabliſhed between the water by the means of a living body, ſuch as the hand. Thus, the production of each gas in the ſeparate quantities of water is completely proved.

It is evident that there are only three poſſible ways of explaining theſe facts: either the galvanic action tends in each quantity of water to take away one of its conſtituent parts, leaving the other in exceſs; or it decompoſes the water, and, ſuffering one of the gaſes to be diſengaged at the end of one of the wires, conducts the other, in an inviſible manner, to the extremity of the other, to ſuffer it to be there diſengaged; or, in the laſt place, the water is not decompoſed, but its combination with ſome principle or other, emanating from the poſitive

poſitive ſide of the pile, produces oxygen gas, and with that emanating from the negative ſide, hydrogen.

The two firſt opinions have been advanced in the claſs by Monge, and the other, in a memoir by Fourcroy; the third belongs to ſome foreigners, and particularly profeſſor Richter of Jena. It appears to be ſo much in contradiction with the whole of the other chemical phænomena, that it would have been impoſſible to admit it, even if the experiment in queſtion could not have been ſatisfactorily explained in another manner.

The memoir of Fourcroy is the reſult of very numerous experiments made by Vauquelin and Thenard; and he adds to a very ingenious explanation of the principal fact, a multitude of circumſtances before unknown. Theſe authors admit the exiſtence of a peculiar fluid which they call the galvanic, and which circulates from the poſitive ſide of the pile towards the negative. According to them, this fluid, on iſſuing from the poſitive ſide, decompoſes the water, and ſuffers the oxygen to eſcape in bubbles; but it combines with the hydrogen to form a liquid which traverſes the water, or the ſulphuric acid, or the human body, in order to reach the extremity of the negative wire, where the galvaniſm abandons its hydrogen, and, in its turn, ſuffers it to eſcape in the form of gas, while it itſelf penetrates the wire.

The following is the experiment by which the authors prove that ſuch is the ſecret progreſs of the phænomenon:—If well waſhed oxide of ſilver be interpoſed between the two waters, the negative wire, near which the hydrogen gas ought to manifeſt itſelf, produces no effervеſcence, and the oxide is in part reduced on the poſitive ſide: the reaſon of this, ſay theſe authors, is, becauſe the galvanic fluid charged with hydrogen loſes it in traverſing the oxide, the oxygen of which takes it up to re-form water.

C. Cuvier lately read in the Inſtitute an intereſting paper on foſſil bones, from which the following is an extract:—Bones which have belonged to ſome animal different from any of thoſe now exiſting on the ſurface of the globe have been found under the earth, in great abundance, in all countries. The ſoil of Siberia is full of ſuch bones; and there is ſcarcely a diſtrict in Germany, Italy, France, England, Ireland, and Spain, in which ſome of them have not been dug up. The foſſil bones found on the banks of the Ohio have been long known. Some of them were found by Dombey in Peru, and the Spaniards brought a whole ſkeleton from Paraguay. It is even probable that ſuch remains of the antediluvian world are to be found in Africa and New Holland.

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Such bones are diſcovered not only in the moſt modern ſtrata, but even in the middle of rocks. The foſſil bones of ſome of the mammalia are found in the neighbourhood of Paris in prodigious banks of gypſum, which are covered with banks of petrified ſea-ſhells, &c. It is an important obſervation, that the older the mountainous ſtrata in which ſuch remains of mammalia are found, the more different are the animals from thoſe of the preſent world. I think I may almoſt with certainty affirm, that all the real foſſil bones which I have had an opportunity of examining with accuracy, belonged to none of thoſe kinds of animals now exiſting on the globe. It is only in regard to the teeth of ruminating animals that this aſſertion cannot be made with certainty. By attentive examination, and the aſſiſtance of my friends and predeceſſors, I have been able to determine from their remains twenty-three ſpecies of animals which, in all probability, do not at preſent exiſt.

1ſt, The foſſil bones which approach near to thoſe of the Indian elephant, but which are, however, different from them: 2d, The elephant of the Ohio: 3d, The rhinoceros with a lengthened head: 4th, The megatherium, of the claſs of the ſloth, found in Paraguay: 5th, The bear of the Gaiſenreuther cavern: 6th, A ſecond ſpecies of bear, ſometimes ſimilar to the former: 7th, A kind of animal from the ſame cavern, forming a middle ſpecies between the wolf and the hyæna: 8th, The foſſil bones of the great elk: 9th, Several kinds of large foſſil tortoiſes: 10th, The ſo called crocodile of Maeſtricht: 11th, The ſingular flying amphibium, of which Collini has given a figure: 12th, Another amphibium, or kind of whale, mentioned by Collini. Beſides the above twelve kinds of animals, deſcribed by others, I was the firſt who determined eleven other kinds; viz. 13th, The animal of Simore, in Languedoc, approaching near to the elephant of the Ohio: 14th, A kind of tapir different from that now exiſting: 15th, A gigantic tapir: 16th, A kind of river horſe of the ſize only of a ſwine: 17th—22d, Six varieties of a ſpecies which, in conformation, ſtands between the rhinoceros and the tapir; of theſe, one kind was as large as the horſe, while the reſt were merely of the ſize of the rabbit; all theſe were found in the gypſum of Paris. 23d, In the laſt place, I found lately, near Honfleur, the bones of a ſpecies approaching near to the crocodile. I do not include here three claſſes of uncertain bones. The firſt claſs are ſimilar to thoſe of animals now exiſting; ſuch as the tiger, hyæna, and the deer. The ſecond claſs are like the bones of ruminating animals, whales, &c. from Verona, Gibraltar, Orleans,

Orleans, Dalmatia, &c. The third claſs are ſtill uncertain, as it is not known whether they are real foſſil bones of the urus, buffalo, and arnis. From this quantity one may judge what may be hoped from the united reſearches of all naturaliſts, when it is conſidered that theſe ſpecies of animals, now loſt, were collected or determined in the courſe of two years by one man, who employed no other means for that purpoſe than his own zeal and the aſſiſtance of his friends. The moſt celebrated foreign naturaliſts, my colleagues in France, thoſe in France as well as in foreign countries who poſſeſs cabinets, and the keepers of public collections, have all been ſo good as to aſſiſt me with their advice, and to communicate to me the facts which were known to them. By the degree of perfection to which my work has been brought, I flatter myſelf that I am entitled to the ſupport of all the learned in Europe. I am now in poſſeſſion of more than 300 drawings: 50 copper-plates are finiſhed, ſeveral others are begun, and I expect, before the work is publiſhed, to enrich it with important matter, which this notice may procure.

ELECTORAL ACADEMY OF MUNICH.

In the ſitting of April 20th, the following prize queſtion, propoſed by the Philoſophical Claſs for 1801, was again propoſed for 1803, as no ſatisfactory anſwer had been received:

Are the azotic gaſes produced by ſo many means totally unlike, and in ſo many different ways, perfectly the ſame in all their chemical properties and fundamental principle (ſimple azote) as that of the atmoſphere? And, Has the nitrous acid the ſame azote for its acidifying principle as the azote of the atmoſphere?

The following have alſo been propoſed for the year 1803 by the ſame Claſs:

To determine, by chemical analyſis as well as ſyntheſis, whether manganeſe be an eſſential component part of every kind of ſteel; and particularly of caſt ſteel, prepared according to Clouet's method?

The Hiſtorical Claſs, at the ſame time, propoſed the following queſtion for 1802:

In what writings is any mention to be found of the Bavarian hiſtory, from the origin of the Bavarian nation to the 15th century? who were the authors of them, and what are their hiſtorical authority and importance?

Anſwers to the two queſtions of the Philoſophical Claſs muſt be tranſmitted, before the 1ſt of November 1801, to the ſecretary of the academy J. Kennedy. The prize is the uſual gold medal of the value of fifty ducats.

XVII. *Intel-*

GALVANISM.

MR. BOLTON, of Birmingham, has ſucceeded in procuring ſuch a ſpark by the galvanic pile as to be able to explode by its means a mixture of oxygen and hydrogen gaſes. His pile conſiſted of 1500 pairs of plates.

Mr. Cruickſhank has alſo ſucceeded in exploding the ſame ingredients by means of the galvanic ſpark. He employs a galvanic battery of his own invention. It conſiſts of troughs made of baked wood, with notches at ſhort diſtances, ſawn in the ſides oppoſite to each other, to receive pairs of ſquare metallic plates, zinc, and ſilver, ſoldered together, and introduced with cement compoſed of reſin and wax. Three pairs of plates, with the intervening cells, occupy about an inch and a tenth of the trough, and the cells are ſo well ſecured with cement that no water can paſs from one to another. One trough is about 26 inches in length, 1·7 inch deep, and 1·5 inch wide, and contains 60 pairs of plates. A galvanic battery may be compoſed by connecting ſeveral of theſe troughs together. When the machine is employed, the interſtices or cells between the plates are filled with water, with ſolutions of ſalts or alkalies, or with dilute acid: it gives ſtrong ſhocks and ſparks, viſible in the day-time; and is found to be eaſily kept in order, and in conſtant action, when that is wiſhed.

C. Fourcroy has juſt publiſhed the following notice:—"Among the new facts with which the ſcience of nature is daily enriched, none is ſo remarkable, or deſerves more the attention of philoſophers, than that relating to the inflammation of iron by galvaniſm. The apparatus for the experiment, made at the French National Inſtitute in the ſitting of the firſt Claſs on the 10th of June, before the Count of Leghorn, conſiſts of eight plates of zinc and eight plates of copper from 10 inches to $7\frac{1}{2}$ inches in diameter, and from a line and a half to two lines in thickneſs, placed upon each other, and ſeparated two and two by pieces of cloth of the ſame ſize, well moiſtened with a ſaturated ſolution of muriate of ammonia. The two pieces of metal at the extremities of this apparatus, the zinc and the copper, were made to communicate by means of two ſilver wires, at the extremity of one of which was a bit of very fine iron wire rolled in a ſpiral form, the free point of which projected beyond the ſilver wire. At the moment of contact, the iron becomes red, and emits very bright ſparks. Sometimes it inflames with

with a real deflagration in the atmoſpheric air. This laſt effect always takes place in oxygen gas, and has a perfect reſemblance to the inflammation which iron experiences when immerſed in that gas after a piece of lighted tinder has been attached to it.

" In the air the wire often becomes red, fuſes into globules, is vaporized at the ſame time that it emits bright ſparks, and the portion of the wire next to that which has been fuſed becomes brittle like the oxide of that metal. Inſtead of forming the communication with wires, if the branches of a pair of ſciſſars (*pair de ciſeaux*) be employed, as is frequently done for trying the piles, there is excited at the extremity of the one which touches the zinc, a bright ſpark, accompanied with a decrepitation.

" The communicating wire when immerſed in hydrogen gas, and in carbonic gas, is alſo luminous; but it is only redneſs or incandeſcence, as the wire does not change colour, and ſtill retains its ductility. This incandeſcence is manifeſted when the experiment is made under mercury with gas and conductors very dry; the effect therefore is not owing to the water decompoſed on the conducting wires, but to two cauſes united.

" The motion of the galvanic fluid reddens the iron; and the air, particularly the oxygen gas in which it is immerſed, inflames it, and burns with decrepitation or deflagration.

" Small parcels of zinc placed on the laſt plate, and touched by a braſs wire communicating with the lower plate, are ſometimes reduced to powder or into ſmoke at the moment of contact, and a very ſenſible decrepitation is then produced, but without inflammation. This phænomenon is not ſo conſtant as the inflammation of the iron wire.

" This inflammation does not take place, unleſs the plates of copper and zinc be from 10 to $7\frac{1}{2}$ inches, at the leaſt, in diameter.

" It is moſt remarkable, that piles compoſed of theſe large plates give only feeble ſhocks, and effect only very ſlowly the decompoſition of water; while if each of the plates be divided into four, and if theſe ſmall plates be placed one above the other, with pieces of cloth moiſtened with an ammoniacal ſolution interpoſed between each pair, they produce a commotion four times as ſtrong, and a much ſpeedier decompoſition of water, without exciting an inflammation of the air. Thus, the galvanic power which ignites metals riſes in a ratio different from that which decompoſes water, and excites muſcular movements.

" The firſt of theſe powers follows the ſize of the metallic plates

plates piled on each other, and the ſecond, the number of the plates, and their ſuperpoſition: the firſt increaſes with the ſize of the plates without increaſing by their number; the ſecond increaſes with the number without ſenſibly increaſing by the diameter of each of them, at leaſt, ſo far as has been tried.

"It is not proved that the galvanic effects are the ſame as thoſe of electricity, notwithſtanding the identity hitherto admitted by very eminent philoſophers between theſe two fluids. It even appears that the more experiments and diſcoveries are multiplied, the more this pretended identity diſappears, or, at leaſt, is weakened. The piles of large plates which inflame iron give no effect, or almoſt none, with the moſt ſenſible electrometers, when the upper plate of zinc is taken from the lower plates by means of ſilk ſtrings, as is done with the electrophorus. We obtained nothing by applying the electrometer of Sauſſure. We tried to produce, by a ſtrong electrical apparatus, the chemical effects produced by galvaniſm; viz. the ſolution of metallic oxides; the precipitation of their ſolutions; and the decompoſition of acids; but the attempt was not ſucceſsful."

A SINGULAR PHÆNOMENON.

A very curious phænomenon was obſerved on the 24th of May, after a ſtorm, in the neighbourhood of Raſtadt. A tub, which had been left in the open air during the rain, having become filled with rain water, there were obſerved on the ſurface of it a great many moleculæ, ſimilar to ſulphur in a ſtate of fuſion, which made it be preſumed that the water muſt be ſtrongly impregnated with ſulphureous matter, and, conſequently, be very inflammable. On trial this was actually found to be the caſe: a ſtick immerſed in it readily inflamed when brought near a very weak fire.

During this ſulphureous rain, a heavy ſtorm of hail ravaged a part of the ſame country ſituated beyond the ſmall rivers Kunſig and Schutter. The hail-ſtones were of the ſize of an egg.

COUNT RUMFORD.

In the biographical ſketch of this gentleman, inſerted in our laſt number, we mentioned his having founded a biennial premium of the value of 60l. to be adjudged by the Royal Society of London to the author (reſiding in Europe) of the moſt uſeful diſcovery reſpecting heat or light.

We take the preſent opportunity of mentioning another circumſtance, of which we were then ignorant, but which ought to be generally known. The Count has alſo founded a like premium of equal value for ſimilar diſcoveries made *in America*, to be adjudged by the American Academy of

Arts and Sciences. The fund for this premium is 5000 dollars in the American three per cent. ſtock, which was transferred to the Academy.

MANUFACTURE OF GUNPOWDER.

We have to requeſt that our readers will have the goodneſs to correct the following *errata* in Mr. Coleman's paper on this ſubject given in our laſt Number, as they materially affect the ſenſe:—Page 359, line 21, for *paſſed* read *preſſed:* p. 360, l. 23, for *if ſparks* read *if no ſparks:* p. 365, l. 4, for *ſulphate* read *ſulphite*; line 13, after *united with a ſmall*, read, *proportion of carbonic acid, ſulphate of potaſh, a very ſmall quantity*, &c.

Mr. Coleman informs us that the *gloom* is not in a heated ſtate when the powder is taking in and out of the ſtove, and that it is furniſhed at the ſame time with a copper and other coverings. He approves, however, heating the ſtoves by means of ſteam-tubes, as mentioned in the note, p. 360.

ANTIQUITIES.

The Babylonian bricks, received by the Eaſt India company from Bagdad, are of two kinds; the one dried in the ſun, the other kiln-burnt or baked in a furnace. Dr. Hager is now engaged upon a work on the Perſepolitan inſcriptions, as they have hitherto been called, found impreſſed on theſe bricks. The ſubject is extremely curious and intereſting, and promiſes no little gratification both to the linguiſt and the antiquary.

Other valuable articles, beſides thoſe arrived from Aſia, are expected from Perſia, ſent by colonel Malcom.—An ORIENTAL MUSÆUM will ſhortly be opened at the Eaſt India-houſe for their reception.

LONGEVITY.

In the community of Pommiers, the department of Iſeres, lives a carpenter, who enjoys full health and ſtrength at the age of 115 years. His eldeſt ſon is 81; his ſecond ſon 80; his only daughter 65. The father is now the ſtouteſt and healthieſt perſon of the family.

BLEACHING.

The next and ſucceeding Numbers of the Philoſophical Magazine will contain a tranſlation of a new work, juſt publiſhed in France, entitled, "*An Eſſay on Bleaching; with a Deſcription of the new Method of Bleaching by Steam, according to the Proceſs of* C. CHAPTAL, *and on its Application to the Arts: by* R. O'REILLY, *of the Academy of Bologna, Member of the Lycæum of the Arts, &c.*

We expect to be able to compriſe the whole in three or four Numbers.

XVIII. *An Eſſay on Bleaching; with the Deſcription of a new Method of Bleaching by Steam, according to the Proceſs of* C. Chaptal; *and on its Application to the Arts. By* R. O'Reilly, *of the Academy of Bologna, Member of the Lycæum of the Arts, &c.*

THE art of bleaching is one of thoſe connected with the firſt ideas of civilization. The theory on which it is founded was entirely unknown to the antients; but the Egyptians were acquainted with the deterſive quality of ſome kinds of clay, and the effect produced by the atmoſphere, moiſture, and light, on the ſtuffs expoſed to their action.

Health and cleanlineſs rendered it neceſſary to deviſe quicker means than theſe; and the property of ſoap and leys of aſhes were therefore ſoon diſcovered.

In the preſent age, the arts, following ſcience with cloſe ſteps, have taken advantage of proceſſes and deterſive menſtrua, the exiſtence of which was before unknown: theſe diſcoveries have ſucceeded each other with ſuch rapidity, that the laſt ſix years have effected a complete revolution in the art of bleaching.

This art divides itſelf very naturally into two quite diſtinct branches, which we ſhall avoid confounding. One of them comprehends the bleaching of animal ſubſtances; the other, that of vegetable matters. We ſhall treat of theſe ſubjects ſeparately, as well as of the different menſtrua and deterſive ſubſtances generally employed.

Bleaching of Animal Subſtances.

The ſubſtances produced by the animal kingdom, which are more particularly employed as veſtments, differ eſſentially from thoſe of the vegetable kingdom. It is on a knowledge of the moſt ſtriking traits, which form the line of demarcation between the two kingdoms, that the art of bleaching is founded.

Vegetables ſerve as nouriſhment to the animals and inſects the ſpoils of which we employ. Animalized by their organs they acquire other properties. *Azote*, in particular, ſeems to be their moſt diſtinguiſhing character: it is ſcarcely found in vegetable ſubſtances. To this principle we may add the exiſtence of ſulphur and phoſphorus, which form ſo many

ſources for thoſe peſtilential exhalations with which the decompoſition of animal matters, by putrid fermentation, is always accompanied.

The affinity of aggregation of theſe ſubſtances, or that law of adheſion which keeps their moleculæ together, is weaker than in the vegetable kingdom; for this reaſon they are ſo eaſily diſſolved and deſtroyed by acids and alkalies, and hence the readineſs with which aëriform fluids are produced.

The bleaching of animal ſubſtances requires the concurrence of alkalies, ſoap, ammonia, and ſulphurous acid. We ſhall here confine ourſelves to an examination of wool and ſilk, as the animal ſubſtances moſt generally employed, and which it is of importance that manufacturers ſhould be acquainted with the method of bleaching in the moſt œconomical and moſt expeditious manner.

Of Wool.

Wool is a kind of hair with which the bodies of ſeveral animals are covered. It is compoſed of filaments or tubes filled with an oily or medullary ſubſtance. The ſides of theſe tubes are perforated with a multitude of ſmall pores, which communicate with the longitudinal tube. By chemical analyſis wool gives a great deal of oil and carbonate of ammonia: cauſtic alkaline leys deſtroy it entirely; and it is to the facility with which it diſſolves in alkalies that we are indebted for the noble diſcovery, made by C. Chaptal, of the *ſoap of wool*. Wool experiences no change in boiling water: this obſervation is of great importance, in regard to the art of which we are now treating; it alters very little when preſerved in a place well aired; acids have very little action on it; when expoſed to a ſtrong heat it enters into fuſion. All theſe facts united prove that wool is a ſemi-oleaginous ſubſtance. The greaſe with which it is covered when on the body of the animal, and from which it is freed by ſcouring, ſerves to confirm this aſſertion.

An examination of theſe chemical facts is neceſſary for underſtanding the principles which ought to direct the artiſt in the bleaching of this ſubſtance. The little action which acids have upon wool, and its unalterability in water, even when aided by caloric, render it neceſſary to have recourſe to alkaline or ſaponaceous leys; but its ſolubility in theſe ſalts ſhows that great prudence and caution muſt be employed. In regard to acids, none have been hitherto uſed but the ſulphurous acid obtained in the gaſeous ſtate by combuſtion.

Of the Bleaching of Wool.

In the preliminary operations to which wool is ſubjected, it is cuſtomary to leave a little of its greaſe to ſecure it from inſects. Wool is often freed from the greaſe by the farmers when they wiſh to ſell it at a high price; but in the ſubſequent manipulations it is greaſed or oiled before it is combed, ſpun, &c.; and as this fat matter attracts duſt, it dirties and thickens the ſtuffs. The firſt kind of bleaching to which wool is ſubjected, is to free it from theſe impurities. This operation is called *ſcouring*. In manufactories it is generally performed by means of an ammoniacal ley, formed of five meaſures of river water and one of ſtale urine; the wool is immerſed for about twenty minutes in a bath of this mixture heated to fifty-ſix degrees; it is then taken out, ſuffered to drain, and then rinſed in running water: this manipulation ſoftens the wool, and gives it the firſt degree of whiteneſs; it is repeated a ſecond, and even a third time, after which the wool is fit to be employed. In ſome places ſcouring is performed with water ſlightly impregnated with ſoap; and, indeed, for valuable articles this proceſs is preferable, but it is too expenſive for articles of leſs value.

Fulling the cloth adds ſtill to the whiteneſs, and if a new degree be neceſſary it muſt be procured by the action of the ſulphurous acid; that is to ſay, of the fumes of ſulphur in a ſtate of combuſtion, or that acid vapour condenſed and combined with water.

Sulphuring is generally performed in an arched or very cloſe chamber, conſtructed in ſuch a manner that the articles to be expoſed to the action of the ſulphur can be ſuſpended on poles. The chamber being filled, a certain quantity of ſulphur is put in a ſtate of combuſtion on flat diſhes having a large ſurface with very little depth: the entrance is ſpeedily ſhut, and all the interſtices around the door are carefully ſtopped to prevent the acceſs of the atmoſpheric air. The acid generated by the combuſtion of the ſulphur penetrates the ſtuffs, attacks the colouring matter, deſtroys it, and effects the bleaching. The ſtuffs are left in the ſtove ſome time after the deflagration has ceaſed. This time varies from ſix to twenty-four hours. They are then taken out, and made to paſs through a ſlight waſhing with ſoap, to remove the roughneſs they have acquired by the action of the acid, and to give them the neceſſary ſoftneſs.

A ſimple deſcription of this proceſs ſhows how imperfect it is. At firſt the acid of the ſulphur acts only on the ſurfaces, and does not penetrate them. This aërial immerſion

is not ſufficient; the gas cannot introduce itſelf to a ſufficient depth into the ſtuffs, and the ſuperficies only is whitened. By taking advantage of the intimate knowledge which we have of the nature of this acid, we have diſcovered a proceſs much ſimpler, more œconomical, and more agreeable to the principles of ſcience.

The ſulphurous acid, or that acid generated by the imperfect combuſtion of ſulphur, differs from the ſulphuric acid (oil of vitriol) by its containing leſs of the acidifying principle, and by being, as we may ſay, the mean term between ſulphur and the ſulphuric acid. As we are deſirous that our work ſhould be underſtood in manufactories, we ſhall ſpeak only very briefly of the chemical properties of the ſulphurous acid, and ſhall proceed to the method of preparing it.

Sulphurous acid gas unites very eaſily with water, and in this combination it may be employed for bleaching wool and ſilk. The ſulphurous acid in this ſtate of liquidity may be prepared by making it traverſe water in an apparatus nearly ſimilar to that uſed for preparing oxygenated muriatic acid. The moſt œconomical method of obtaining it is, to decompoſe ſulphuric acid (oil of vitriol) by the mixture of any combuſtible matter capable of taking from it a part of its oxygen. In exact experiments of the laboratory, where the chemiſt is deſirous of having great purity, it is obtained by means of metallic ſubſtances, and particularly by mercury; but for the purpoſe of which we are treating, where great œconomy is required, we would recommend the moſt common ſubſtances. We ſhall therefore give the following proceſs:

Take chopped ſtraw, or ſawduſt, and introduce it into a matraſs; pour over it ſulphuric acid, applying at the ſame time heat, and there will be diſengaged ſulphurous acid gas (vapour of ſulphur), which may be combined with water in the following apparatus, and by the following method:

Place long necked matraſſes on a furnace, and make them communicate with a tubulated flaſk into which a little water has been put to abſorb the ſmall portion of ſulphuric acid (oil of vitriol) that may paſs without being decompoſed through this firſt reſervoir. Care muſt be taken to apply a ſmall ſafety-tube, one of the extremities of which muſt be immerſed ſome lines in the water, to guard againſt abſorption. A tube with a double bending conducts the acid into flaſks or other veſſels, where it muſt at length combine with the water.

We would propoſe uſing, inſtead of the tubulated flaſk, a cylinder of lead, or of fir, or any white wood, hooped with varniſhed

varniſhed iron (to prevent ruſting) of a pretty conſiderable height, terminating at top with a Wolf's bottle, the bottom of which muſt be taken out, and which is to be placed in a collar formed in the leaden cylinder; care being taken to cement it with a luting of wax to render it impermeable to fluids. This capital of glaſs will enable the operator to ſee the quantity of air bubbles diſengaged from the ſurface of the water, and thus to appreciate the progreſs of the ſaturation, while the weight of this narrow and high column of water preſſing on the bubbles of ſulphurous acid gas, in proportion as it is diſengaged from the extremity of the tube at the bottom of the cylinder, will facilitate its combination with the water, and accelerate its ſolution in that fluid. That nothing may be loſt, two or three of theſe cylinders can be united in the ſame way as is done with a ſeries of Wolf's bottles. A cock adapted to the bottom of each cylinder will facilitate the diſcharge into the immerſing tubs.

The apparatus which we would employ for the immerſion of woollen and ſilk ſtuffs in leys of ſulphurous acid are perfectly ſimilar to that which we ſhall deſcribe hereafter for immerſion in oxygenated muriatic acid, and which we have conſtructed according to the principles of Rupp*. It was by reaſoning upon his apparatus with C. Widmer, of Jouy, that we conceived the deſign of the preſent one, which is now making at the manufactory of Eſſone. Let us ſuppoſe an oblong box, divided in the middle by a partition, and on each ſide of it a large reel, on one of which the ſtuff is rolled up: in each angle are placed rollers, over which the ſtuff is conveyed before it paſſes the partition, and traverſes a like number of rollers, which conduct it to the other reel. The object of this diſpoſition is to cauſe the ſtuffs to paſs through the bleaching ley, and to expoſe to its action the greateſt ſurface poſſible.

To turn theſe reels, an axis or column of glaſs paſſing through a collar of leather is employed. One of the extremities of this axis, which is ſquare, is inſerted into the axis of the reel, while the other is adapted to a handle, which gives it a rotary motion. By this diſpoſition there is no need for employing any metallic ſubſtance internally. To prevent the diſperſion of the gas, the covering of this apparatus is furniſhed with a border which fits exactly into the box, and of which an inch, at leaſt, ought to be immerſed into the deterſive liquor.

* For an account of Mr. Rupp's proceſs and apparatus here alluded to, ſee Mancheſter Tranſactions, vol. v.; or Philoſophical Magazine, vol. ii. —Edit.

For bleaching woollen ſtuffs we propoſe the following method:—The ſtuffs are firſt to be ſcoured by a ſlightly alkaline ley in the proportion of a pound of potaſh to 50 pounds of wool; the ley muſt be heated to the temperature of 30 degrees: the old proceſs, by means of ſtale urine, already mentioned, may be alſo employed. Urine is preferred, becauſe it holds in ſolution only a ſmall quantity of ſalt incapable of hurting the wool. When the greaſe is diſſolved, and the wool has been perfectly rinſed, it is to be waſhed in warm ſoapy water: this part of the ſcouring proceſs is performed ſometimes in the fulling-mill, ſometimes with beaters, and ſometimes by treading in the tub. In all theſe caſes the ſtuffs muſt be freed from greaſe by repeated waſhings before they are ſulphured. If a very bright whiteneſs be required, it will be proper to expoſe them to heat a ſecond, and even a third time, always in water a little ſoapy, made with two ounces of that ſubſtance for each pound of wool. It will be better to repeat this operation, turning the ſtuff for half an hour at each immerſion with a ſtick, than to run the riſk, by too ſtrong a ley, of injuring the quality of the wool. After the ſtuff has been carefully rinſed it is carried to the tubs to be immerſed in liquid ſulphurous acid, or ſulphur water, as the workmen term it: the pieces are rolled upon the reels, and are drawn through the ſulphurous acid by turning them until it is obſerved that the whiteneſs is ſufficiently bright. They are then taken out, and left to drain on a bench covered with cloth, leſt they ſhould be ſtained in conſequence of the decompoſition of the wood by the ſulphurous acid: they are next waſhed in river water, and Spaniſh white is employed if it ſhould be judged neceſſary. This operation is performed by paſſing the pieces through a tub of clear water in which about eight pounds of Spaniſh white have been diluted. To obtain a fine whiteneſs, the ſtuffs, in general, are twice ſulphured. According to our proceſs, one immerſion and reeling for two or three hours is ſufficient. Azuring or blueing is performed by throwing into the Spaniſh-white liquor a ſolution of one part of Pruſſian blue to four hundred parts of water, ſhaking the cloth in the liquid and reeling it rapidly.

The operation is terminated by a ſlight waſhing with ſoap, to give ſofineſs and pliability to the ſtuffs. The final operations of drying, ſtretching, preſſing, &c. are foreign to the proceſſes which are the object of this eſſay.

Before venturing thus to recommend the uſe of the liquid ſulphurous acid, we made a great many experiments on ſpun wool and woollen ſtuffs, and always with the moſt complete ſucceſs.

Of Silk.

Silk is a diaphanous matter ſpun by a caterpillar, and formed of a ſubſtance contained in its body, which becomes hard in the air. This inſect inhabits warm climates, being indigenous in Aſia: it was naturalized in Europe about the time of the downfal of the Roman empire.

The filaments prepared by the ſilkworm are rolled up in a cod or ball. In the ſtate in which we find it, it is covered with a yellow varniſh, which deſtroys its brilliancy and renders it rough. Silk by chemical analyſis gives carbonate of ammonia and oil; water at a boiling heat produces no effect upon it; alcohol makes it experience no change, but concentrated alkaline leys attack and diſſolve it.

To give ſplendour to ſilk, it muſt be freed from its varniſh. This covering is ſoluble in alkaline leys. Silk is ſcoured by means of ſoap, which ought always to be choſen of a good quality for fear of ſtaining it, and ſometimes with diluted muriatic acid. Silk by being ſcoured with ſoap loſes a fourth of its weight. The matter diſengaged from it is exceedingly fœtid; if a ſkain of ſilk be not waſhed in abundance of water after being ſcoured, it will become hot in a few days, putrid fermentation will take place, and ſmall white worms will be produced, which will devour the glutinous and ſaponaceous matter that remains in the ſilk. The liquor in which it is boiled putrefies, and becomes uſeleſs. Macquer has very properly obſerved, that if the yellow varniſh can be precipitated to the bottom of the ſoapy liquor before putrefaction takes place, the ſoap may be recovered, and the dyer will thus make a conſiderable ſaving.

Even when the beſt ſoap is uſed, it is generally ſuſpected that it injures the whiteneſs of the ſilk. The ſplendour of the Chineſe ſilks is brighter than that of the European, and the Chineſe employ no ſoap in their operations. We remember that the Academy of Sciences propoſed a prize for a method of ſcouring without ſoap, which was gained by Rigaud, who performed it by a ſlight alkaline ſolution. Colomb even diſſolved the varniſh of ſilk in water, notwithſtanding the opinion entertained of its inſolubility in that liquid. He expoſed the raw ſilk for nine hours to ebullition, and freed it from the varniſh with the loſs of a fourth of its weight.

Notwithſtanding the whiteneſs which ſilk acquires by theſe different operations, it muſt be carried to a higher degree of ſplendour by expoſing it to the action of ſulphurous

acid gas in a cloſe chamber, or by immerſing it in that acid in a liquid ſtate.

Of the Bleaching of Silk.

To obtain the complete bleaching of ſilk it is ſubjected to ſeveral operations. The firſt tends to deprive it of the gum and colouring matter which externally cover its filaments; the ſecond, to give it a juſt degree of whiteneſs: ſometimes the ſcouring is ſeveral times repeated; it is then baked, blued, and ſulphured.

It is freed from the gum by a ley of ſoap and ſoft water, in the proportion of from twenty-five to thirty pounds of the fineſt kind of ſoap for a hundred pounds of ſilk. The boiler is then expoſed to the action of the fire, and the heat is ſo far kept down by a little cold ley, as to maintain, as uniformly as poſſible, the temperature of about 90 degrees of Fahrenheit. The ſilk is turned, to expoſe all the parts of the ſkains to the action of the bath. The ſkains are then twiſted on the wringer to free them from the ley. They are put into bags of coarſe cloth in packets of about twenty-five pounds.

The baking, as the workmen term it, though a boiling, is performed by throwing all theſe bags into a kettle of freſh ley compoſed as the preceding, making it boil for two or three hours, and ſtirring it often with a batton leſt the ſilk ſhould adhere to the bottom: it is then taken from the bags, after which it is opened and ſpread out. When the ſkains have been ſuffered to drain they are again wrung, and then rinſed in a ſtream of water. When they have been well waſhed and beat in the running water, they are examined, to ſee whether there be any ſpots not diſſolved which may render it neceſſary to repeat the operation.

To give it whiteneſs, a ſoapy ley is prepared of four ounces of ſoap for each pound of ſilk, diluted with water till it form a good lather when well ſtirred and beaten. The ſame heat is maintained as in the preceding operations, and never that of boiling water; the ſilk is preſſed for half an hour at leaſt, and after being turned for another half hour it is removed; and, not unfrequently, it is *baked* before it is ſubjected to the operation of ſulphuring.

This *white baking* is performed in a ley ſimilar to that above deſcribed, and in bags like thoſe employed for boiling the ſilk in its raw ſtate. This baking finiſhes the bleaching with ſoap. The ſilk being taken from the bags is wrung, and rinſed in running water. If an azured white be required, it is made to paſs through blue; after being azured, and when

when the ſilk is dry, it is then ſulphured, and the bleaching is complete.

All theſe proceſſes are exceedingly deſtructive: thoſe which I am about to propoſe will make a total change in the method of bleaching ſilk. I have already mentioned the prize granted by the Academy to Rigaud for ſcouring by means of a ſlightly alkaline ley, and the ſucceſs obtained by the abbé Colomb in having ſucceeded to diſſolve the varniſh of ſilk by the action of boiling water at a very high temperature: theſe inconteſtable facts furniſh more than the neceſſary proofs of the goodneſs of our method.

Take a ſolution of cauſtic ſoda, ſo weak as to mark only a fourth of a degree at moſt of the areometer for ſalts, and fill with it the boiler of the apparatus for bleaching with ſteam. Charge the frames with ſkains of raw ſilk, and place them in the apparatus until it is full; then cloſe the door, and make the ſolution boil. Having continued the ebullition for twelve hours, ſlacken the fire, and open the door of the apparatus. The heat of the ſteam, which is always above 250 degrees, will have been ſufficient to free the ſilk from the gum and to ſcour it. Waſh the ſkains in warm water, and, having wrung them, place them again on the frames in the apparatus, to undergo a ſecond boiling. Then waſh them ſeveral times in water, and immerſe them in water ſomewhat ſoapy to give them a little ſoftneſs.

The laſt degree of bleaching is effected by making the ſkains to paſs through ſulphurous acid, making uſe of the proceſs and apparatus before recommended for bleaching wool, and which ſupplies here the place of ſulphuring. The incalculable advantage of this proceſs in compariſon of any other, conſiſts chiefly in the poſſibility of following its operations progreſſively, and without running the riſk of injuring the quality of the ſilk by too violent leys.

Of the Bleaching of Vegetable Matters.

The characters and properties of vegetable ſubſtances are widely different from thoſe we have deſcribed. As organic matters, they contain oxygen, hydrogen, and carbon; but azote, which acts ſo important a part in the animal kingdom, is rarely found in them, and much leſs phoſphorus and ſulphur.

The ſubſtances found in the interior of plants are, like thoſe obſerved in the interior of organized bodies, the reſult of vegetable ſecretion. The nouriſhment of vegetables is derived from the boſom of the earth, and this combination of prin-

ciples

ciples, abſorbed by the roots, with the juices aſſimilated in their vaſcular veſſels, produces new compounds.

The deſtruction of plants exhibits phænomena which have very little reſemblance to thoſe exhibited by the diſſolution of animal bodies; but the laſt reſult is always the natural deſtruction of the combination of their conſtituent principles, the union of hydrogen and oxygen forms water, and the combination of oxygen and carbon forms carbonic acid. It is on theſe principles and modifications, applied to the treatment of vegetable matters, that the art of deſtroying colour is founded; it is a decompoſition begun and checked in proper time, or the deſtruction of ſome principles in order to preſerve others.

To bleach vegetable ſubſtances requires the concurrence of ſeveral menſtrua or deterſive ſubſtances; ſuch as ſoda, oxygenated muriates, calcareous ſulphuret, and ſoap. There are ſeveral proceſſes for depriving hemp, flax, and cotton, of their colour, which may be claſſed in the following order:

1ſt, Bleaching in the open air, with the aſſiſtance of alkali and ſoap.

2d, Bleaching by water alone.

3d, Bleaching by the oxygenated muriatic acid, ſubſtituted for the action of the atmoſpheric air; and this method is divided into four diſtinct proceſſes: the firſt conſiſts in employing the oxygenated muriatic acid alone; in the ſecond, potaſh is mixed with this acid to condenſe the gaſeous vapour and deſtroy its ſuffocating odour; for the third, oxygenated muriates diſſolved in water are employed; and in the fourth, ſulphuret of lime is united with this acid.

4th, Bleaching by the ſteam of alkalino-cauſtic water, where the air and ſolutions of oxygenated muriates coincide alternately with the action of the ſteam.

Of Hemp and Flax.

If hemp and flax be examined immediately after they are pulled, we obſerve an union of fibres cemented together, which form filaments; theſe fibres are moiſtened by the ſap, and the ſtalks, formed of bundles of filaments, are enveloped in a ſemi-ligneous ſubſtance, and covered with a very thin bark. The ſap of textile plants differs from thoſe of ligneous plants; it approaches near to extractive matter; it is neither ſaponaceous, nor reſinous, nor aqueous, but it poſſeſſes ſomething of all theſe properties: it is ſoluble in water like the ſap of wood, it precipitates itſelf in flakes by the action of oxygenated muriatic acid, but theſe two kinds of ſap are diſtinguiſhed

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by one very ſtriking character: that of trees almoſt always contains tanning principle, or gallic acid; that of textile plants never poſſeſſes any. The ſap, therefore, is nothing elſe than real vegetable chyle; a nutritive juice, compoſed of water, mucilage, and ſugar, with ſome portions of carbon, phoſphorus, and lime.

Theſe preliminary obſervations are indiſpenſably neceſſary for comprehending the theory of the operations to which hemp and flax are ſubjected. Deprive theſe plants of their ſap as ſoon as they are pulled, decompoſe the extracto-mucilaginous matter, which occaſions the aggregation of their filaments, and you will have performed the firſt operation, which is called *watering*. The hemp or flax, tied up in bundles, is immerſed in ſtagnant or ſpring water, in which the bundles are preſſed down by means of ſtones. Well water and brackiſh water muſt be carefully avoided, as well as that which flows over gypſeous ſoil. Such water accelerates putrefaction, and hurts the quality of the hemp and flax. This is perfectly agreeable to the principles of chemiſtry; it is thus that a little ſalt accelerates animal putrefaction, while a great deal tends to prevent it. The portion of ſaline ſubſtances taken up by the water haſtens corruption by extending the putrid fermentation, which ought to operate only on the juices, even to the filaments, which it blackens and ſpoils.

The fibres of flax are ſeparated by letting them remain in ſtagnant water until the mucilaginous membranes which connect them are deſtroyed by putrefaction. During its immerſion their ſap is decompoſed and diſſolved, the bark ſeparates from the ligneous body, and the fibres are inſulated. Some days are ſufficient for the proceſs of watering.

To aſcertain the period of watering, which always varies according to the kind of plants, the degree of their maturity, and the nature of the ſap, a handful of the flax is taken from the pond, and broken and rubbed between the fingers: if the ſtalks are ſtill green, but brittle, and break with the leaſt effort, the bundles muſt be taken out: a longer immerſion might extend the decompoſition even to the fibrous texture. The putreſcence decompoſes the water; there is formed carbonated hydrogen peſtilentially fœtid; the fiſhes die, and the air becomes infected. In countries where a great deal of hemp and flax are cultivated, there are laws which forbid theſe ſubſtances from being watered in rivers and other ſtreams.

The hemp and flax, when taken from the water, are ſpread out on the graſs to dry. During the fermentation and decompoſition

compoſition which thence reſult, there is a ſpeedy combination of oxygen and carbon. Expoſure on the graſs facilitates the eſcape of the carbonic acid into the atmoſphere. The plants become of a whitiſh gray colour, which is called a flaxen gray.

It is known that a ley very ſlightly alkaline may be ſubſtituted with advantage for this long and noxious operation: it is therefore certain that a chamber of from 20 to 30 feet in length, into which the ſteam of alkalino-cauſtic water of the ſtrength of *one-fourth* of a degree only is introduced, will be ſufficient to produce the ſame effect as watering, on an immenſe quantity of hemp and flax ſuſpended on baſket-work, in leſs time and with leſs expenſe than are required for the different manipulations of watering. The loſſes occaſioned by the negligence of workmen, who, by ſuffering the hemp and flax to macerate too long, give time to the decompoſition to reach the filaments, which renders them brittle and occaſions a conſiderable waſte, will alſo be avoided. In our proceſs the artiſt can follow every moment the progreſs of his operation, and ſtop it at the favourable period.

Hemp and flax, after being watered, muſt be dried in a kiln or ſtove. A fibrous ſkeleton which exhibits a number of ſmall tubes, the interior of which is compoſed of a fibrous tiſſue, and the exterior of a ligneous, will then be obtained: one of theſe muſt be preſerved, and the other rejected. This is the object of the ſubſequent operations of beating, heckling, &c.

The ligneous tiſſue, or this bark, as the workmen call it, is thrown away as uſeleſs, and a certain portion of the fibres of the hemp and flax, which ſtill adheres to it, is thus loſt, notwithſtanding the care of the workmen during theſe different manipulations.

In the neighbourhood of mills, where the operations of beating, heckling, &c. are performed, I have ſeen heaps of that ſubſtance thrown away: it cannot be converted into manure, on account of the long time required for its decompoſition; and I have often lamented the loſs of a matter ſo valuable, and which might ſo eaſily be employed for ſome uſeful purpoſe. By macerating it in water, and ſubjecting it to the other operations of a paper manufactory, it may be converted into pulp proper for the fabrication of every kind of paper*: it might even be previouſly bleached, or bleached in the ſtate of pulp, by the different proceſſes which are the

* In Britain this ſubſtance is often ſo made uſe of.—Edit.

object

object of this eſſay. The price of rags is already high enough, beſides their ſcarcity; and Belgium, the ci-devant Britanny, Auvergne, Alſace, &c. are every year covered with heaps of this ſubſtance, which the paper-makers might procure at a very low price, and which would afford a rich mine to be worked by the induſtrious artiſt.

Hempen and linen cloth, when they come from the hands of the weaver, are charged with flour paſte called *dreſſing*, employed by the manufacturers to aid the tenſion of the threads during the weaving: ſome manufacturers immerſe their cloth in tubs, or expoſe them in running water, or boil them, to free them from this ſubſtance. Theſe are bad methods, which betray abſolute ignorance of the proper principles. The beſt is to immerſe the cloth from forty-eight to fifty hours in a tub filled with ſoft water, at the temperature of from 60° to 75°: the kind of fermentation which enſues is ſufficient to decompoſe the paſte, and is never ſtrong enough to attack the filaments of the thread: the cloth is then to be rinſed in running water, by the help of a fluted cylinder, which entirely frees it from that amylaceous ſubſtance.

This operation gives to cloth a firſt degree of bleaching, which ariſes merely from the deſtruction of a part of the colouring matter during the fermentation, which opens the threads of the cloth, ſlackens and ſoftens their tiſſue, and ſwells their fibres: it may be ſeen that it has reached its proper term by obſerving all theſe phænomena, and when the colour of the cloth is uniform throughout.

After the cloth has been completely rinſed in running water with the cylinder, it remains of a grayiſh white colour: the tint which oppoſes its perfect whiteneſs ariſes from extracto-reſinous matter which remains combined with the filaments, and from which they muſt be freed. This is the operation properly called bleaching, whatever may be the operation employed for accompliſhing it. Theſe different proceſſes will be deſcribed in the courſe of this work.

Of the colouring Matter of Hemp and Flax.

Before we proceed to a deſcription of the different proceſſes for bleaching, it is of importance that we ſhould ſay a few words reſpecting the colouring matter of flax. This ſubject has been fully treated of by the celebrated Kirwan, from whoſe experiments it is abundantly proved that the colouring matter extracted by the action of alkalies is a peculiar reſin, which differs from pure reſin by being inſoluble in eſſential oils, and in having ſome reſemblance to lacks. Having procured ſome of this ſubſtance, by ſeparating it from what

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the workmen call *dead ley*, by ſaturating the alkali with acids, and in that manner obtaining it in the form of a greeniſh precipitate, which he carefully waſhed, he made the following experiments to determine the action of alkalies upon it:

Eight grains of it were digeſted in a ſolution of cryſtallized ſoda ſaturated at the temperature of 60° of Fahrenheit: the ſolution inſtantly aſſumed a dark brown colour. Two meaſures of this ſolution, weighing each 275 grains, were not entirely diſſolved by this ſubſtance; but two meaſures of a ſolution of potaſh diſſolved the whole of it.

One meaſure of cauſtic ſoda, the ſpecific gravity of which was 1·053, diſſolved almoſt the whole of it, leaving only a white reſiduum.

One meaſure of cauſtic potaſh, the ſpecific gravity of which was 1·030, diſſolved the whole of it.

One meaſure of an alkaline ſulphuret, the ſpecific gravity of which was 1·170, diſſolved the whole matter.

One meaſure of ammonia diſſolved alſo a portion of this ſubſtance.

Though theſe experiments were ſufficient to ſatisfy Kirwan's doubts, he thought it neceſſary to repeat them with the ſaline ſubſtances uſually employed in bleaching as well as with ſoap.

He diſſolved, therefore, an ounce of common ſoda, and as much Dantzic potaſh, each in ſix ounces of diſtilled water: eight grains of the green matter were put into a meaſure of an ounce of each ſolution, and then digeſted for three hours and a half in a heat equal to 180° of Fahr. The diſſolving power of the Dantzic potaſh was ſuperior to that of the ſoda; for, an ounce of the ſolution of ſoda was ſtill required, and half an ounce only of the ſolution of potaſh, to diſſolve the whole of the ſubſtance.

An ounce of white ſoap was diſſolved in 18 ounces of diſtilled water. The ſolution was turbid, and it could not be rendered tranſparent but by heating it almoſt to the point of ebullition, and then the operation was difficult; for when the liquor, by chance, began to boil, it was thrown to the diſtance of more than three feet from the matraſs. Three ounces of this ſolution were required to diſſolve eight grains of the colouring matter.

In order to compare the reſpective ſtrength of theſe ſolutions, it muſt be obſerved, that an ounce of the ſoda of the ſhops contains only 114 grains of pure ſoda: ſuppoſe the ſolution to have been made in ſix ounces of water, each ounce of water will contain 19 grains of pure alkali, while

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an ounce of the like ſolution of Dantzic potaſh will contain 50 grains.

The deterſive force of lime was tried without ſucceſs; three ounces of water, ſaturated with lime, produced ſcarcely any effect on the colouring matter: theſe three ounces contain at moſt three grains of pure lime.

Deſcription of Apparatus.

Fig. 1. (Plate II.) the new apparatus propoſed by the author for preparing liquid ſulphurous acid, and which may ſerve alſo for diſtilling oxygenated muriatic acid. A, a ſection of the furnace, which is a ſand bath, and contains three flaſks (as may be ſeen in the horizontal ſection fig. 2). Each flaſk is furniſhed with a bent tube *a*, for pouring in the ſulphuric acid; and from it the liberated gas paſſes by the tube *b* into the receiver B, which is made of lead. This receiver has five necks (vide fig. 2.): three of them receive the tubes connected with the three flaſks, one receives a ſafety-tube *c*, intended to prevent abſorption, and the 5th the bent tube *d*, which connects it with the ſeries of tall Wolfs C, D, &c.

Fig. 3. ſhows the way in which it is propoſed to alter Mr. Rupp's apparatus. The ſtuff is made to paſs over rollers in the corners, &c. of the box in going from one reel to another, and the axes come through leather collars in the ſide inſtead of the top of the box. The engraving repreſents a vertical ſection.

Fig. 4, a boiler and ſteaming chamber. A, the boiler, charged with ſtale urine, rendered cauſtic by the addition of quicklime *. The ammonia thus diſengaged paſſes through the tube B into the chamber C, which is furniſhed with reels and rollers for winding the ſtuff, and thus expoſing it to the action of the vapour. At the corner *a*, the uncondenſed vapour can paſs into the worm-tub D to be condenſed, and returned to the boiler by the tube *b c*. Or it may be received into the tub E by ſhutting the cock at *c*, and opening the cock *n*. The opening into the chamber, *i. e.* the door, is on the top, and ſhuts air-tight. With this apparatus, vapour or ſteam of any kind may be employed for the purpoſe of bleaching.

[To be continued.]

* For this method of applying ammonia to the purpoſes of bleaching, the world is indebted to Mr. Crooks, of Edinburgh, who, a conſiderable time ago, took out a patent for it for England. The ſame gentleman having, along with Mr. Turnbull, improved the proceſs, and extended the principle to the uſe of fixed alkalies alſo, aſſiſted by the action of the ſteam of boiling water, patents have ſince been taken out in their joint names for England, Scotland, and Ireland. Of this invention we gave an account in our ninth volume.—EDIT.

XIX. *Re-*

XIX. *Researches respecting the Preparation of the Citric Acid.* By *Professor* PROUST.

ONE of my friends, Don Antonio Hernandez del Valle, secretary to the consulship of the Havannah, wrote to me in the year 1795, during his residence at Cadiz, before he embarked, to request some information respecting the best method of preserving lemon juice during long voyages; a process in which no one had ever yet properly succeeded. As his acquaintance with chemistry inspired him with a design to make experiments on this subject, he desired me to make some researches, that he might compare them with those he proposed to undertake in regard to this acid as soon as he should reach the place of his destination.

What I am going to say on the subject will make no addition to our knowledge on the nature of the acid of lemon-juice, since the indefatigable Scheele has left nothing to be wished for on this subject; I only intend to reduce to fixed data his formula for the extraction of this acid, and to ascertain whether the substances which oppose its preservation are of such a nature as to be capable of being separated by means that depend less on the art of our laboratories.

The lemon juice I employed had been clarified by filtration; and it had been kept for a year in a cellar, covered with a little oil, according to the usual method of the shops.

I. Spirit of wine mixed with this juice in a pretty large quantity, did not render it turbid even after being kept 24 hours.

Having evaporated about three pounds of it, in a gentle heat, to the consistence of syrup, I observed, as Scheele had done, that the citric acid announced no disposition to crystallize even when carried by evaporation nearly to the consistence of extract. The reason of this, no doubt, was, that this acid, which is very crystallizable, requires, however, but little water for its crystallization.

Lemon juice, by evaporation, assumes the colour and disagreeable odour of the extract of plants; when redissolved in water, it reproduces a juice of a taste which still participates of that of extracts. In a word, evaporation, which gives no hope of the possibility of separating the principles which alter it, adds to it the inconvenience common to all extracts, which is, that their solution in water never brings back the juice to that taste which it before had in the plants.

Dubuisson, in a supplement to his *Art du Distillateur*, says, that the evaporation of lemon-juice in a gentle heat makes

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it depoſit mucilage, and puts it into a ſtate of being preſerved. I obſerved nothing of this kind; nor was I ſurpriſed on that account, as mucilage and extractive matter are not of a nature to be ſeparated by ſuch means. The latter, in particular, is not among the number of thoſe which, forming a pellicle, abandon their ſolvent in conſequence of the inſolubility they acquire by becoming ſaturated with oxygen. Lemon juice thus prepared will keep well, no doubt; but where? In our cellars, and not in the hold of a ſhip proceeding towards the equinoctial.

It is cuſtomary, as I have been informed by Don Hernandez, to boil the lemon juice pretty ſtrongly before it is put on board; but, beſides the burnt ſmell it contracts, it ferments ſtill in the bottles, and makes them burſt when the ſhips approach the line.

II. The concentration of lemon juice by congelation, propoſed by Georgi, is attended with no better ſucceſs. It brings it to the conſiſtence of ſyrup from being a more powerful acid, eſpecially if it be reduced to one-eighth of its volume. But this proceſs neither deſtroys the mucilage nor the extract; and beſides, its not being practicable in the countries where the lemon tree grows, becauſe it is a native of hot climates, it may be readily conceived that this ſyrup will not ſtand the heat experienced in ſea voyages any more than that prepared by means of fire.

III. Dr. Brugnatelli announces that lemon juice diluted in ſpirit of wine frees itſelf in the courſe of a few days from part of its mucilaginous matter; and he adds, that, after the alcohol has been ſeparated by diſtillation, the acid is obtained as pure as it is when concentrated. It may be readily believed that by this proceſs the object is not entirely accompliſhed; for I ſhould aſk the author, what has become of the extractive part found by Scheele in lemon juice?

I was deſirous of trying whether it was poſſible to render it pure by means of charcoal powder, ſo much extolled, and which has given occaſion to ſo much diſpute in Germany; but I found that this proceſs was attended with no real effect.

It follows from this review, that, except the formula of Scheele, no method has yet been found of ſeparating the mucilage and extractive ſubſtance of lemons, and that we muſt adhere to it until a ſimpler one ſhall be diſcovered.

IV. Lemon juice, evaporated to the conſiſtence of ſyrup, and diluted in ſeven or eight times its volume of ſpirit of wine, becomes turbid, and depoſits a matter ſomewhat browniſh, clammy, and which diſſolves completely in water. This is pure mucilage.

This ſpiritous mixture, diſtilled in a retort, leaves the

juice at the ſame degree of conſiſtence, and with the ſame colour; and though it has loſt the mucilage it cannot be yet rendered cryſtallizable by concentration, becauſe its extractive matter, ſoluble in water, remains in it. The juice employed in theſe experiments gave about five or ſix degrees of Baumé's areometer. When dried as much as poſſible, without altering it, it produced 48 grains per ounce of dry matter.

V. Four ounces of white chalk were expoſed to heat, with a pound of water, in a ſilver baſon. It was afterwards ſaturated by pouring lemon juice ſucceſſively into it as long as an effervescence was produced. When this point was obtained, about an ounce of juice was added, in order to be certain that the earth was completely ſaturated. For this proceſs 94 ounces were required.

When the mixture had cooled it was decanted from off the citrate, which occupied the bottom of the baſon. It was then waſhed three or four times with cold water in order to ſeparate all the remainder of extractive matter, and there were obtained by theſe means ſeven ounces and half a dram of white calcareous citrate, pulverized and light.

The liquid ſeparated from the citrate added to the water employed in the waſhing was evaporated to a certain point, by which means there were obtained alſo $3\frac{1}{2}$ drams. The product of the citrate was conſequently 7 ounces 4 drams; and by adding half a dram, which, according to my eſtimation, remained in the extract of the liquids evaporated, there were obtained altogether 60 drams and a half of this citric ſalt.

VI. As the citric acid, by uniting with the chalk, expelled the carbonic acid, the queſtion now is to know the amount of the latter, in order to aſcertain the quantity of the citric acid which replaced it.

Analyſis of this Chalk.

A hundred parts, converted into lime by calcination, were reduced to $56\frac{1}{2}$. The loſs of acid and water was therefore $43\frac{1}{2}$ per cent. A hundred parts of the ſame chalk, diſſolved by nitric acid, loſt only from 40 to 41 of carbonic acid. Conſequently, there is about three per cent. of water in this earth. The nitric acid ſeparated alſo about three of argil ſlightly ferruginous. The quintal of chalk may then furniſh the following reſult:

Argil	- -	3
Water	- -	3
Carbonic acid	-	$40\frac{1}{2}$
Lime	- -	$53\frac{1}{2}$
	Total	100

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In 4 ounces or 32 drams of chalk, then, we have the following quantities, a few fractions excepted:

Argil	-	-	1
Water	-	-	1
Carbonic acid		-	$12\frac{3}{4}$
Lime	-	-	$17\frac{1}{4}$
		Total	32

It is now evident that the earthy base furnished to $60\frac{1}{2}$ of citrate by 32 drams of chalk, was $17\frac{1}{4}$ drams of lime, or $18\frac{1}{4}$ including the argil.

It is also evident that the citric acid, which assumed the place of the $12\frac{3}{4}$ drams of carbonic acid, amounted to $41\frac{1}{4}$ drams. If to these $58\frac{1}{2}$ drams of pure citrate, 2 drams of water and argil be added, we shall have for the whole product $60\frac{1}{2}$ drams.

From these proportions it will be found by calculation that it must contain about $30\frac{2}{3}$ of lime, mixed with a little argil, in a quintal of citrate; but, having calcined a hundred parts of this citrate, it left $31\frac{1}{2}$ of lime, a proportion very near to the former; and if we deduct from this lime about $1\frac{1}{2}$ of argil, we shall have in the quintal of citrate,

Lime	-	30	100
Citric acid	-	70	

But the real quantity of acid will be less by all the water with which it may be united in the citrate. This, however, I did not examine.

The citrate of chalk, as Scheele has remarked, is very little soluble in water, and the solution has no striking savour. It is not rendered turbid by spirit of wine, and it produces no change either on turnsole paper or on the solution of sulphate of potash. The fluoric, phosphoric, and boracic acids make no impression upon it; but the oxalate of potash and the oxalic acid precipitate from it the lime.

The extractive ley contains, besides mucilage and extract, malate of lime, which spirit of wine immediately precipitates from it, if it has been concentrated by evaporation. Extract of this ley has the colour, smell, and savour, common to the extracts of plants. If it has been concentrated only to the consistence of syrup, it speedily becomes covered with mouldiness.

The colour of lemon juice is not changed by a few drops of the nitrate of iron, because excess of the acids redissolves the gallate, or combination of iron with the astringent principle; but if this excess be taken away by potash, the vinous colour,

but weak, makes its appearance, which shows that the astringent principle is only in small quantity.

The citrate of lime kept under water, exposed to the sun during the heat of summer, becomes putrid, and the water is covered with a stony crust, which is carbonate of lime. The citric acid, like the other vegetable acids, is destroyed by putrefaction. Its carbonaceous part united to the oxygen of the water, which is decomposed, and thus transformed into acid, reproduces chalk: this putrefaction is always accompanied with an escape of bubbles, which are only carbonaceous hydrogen.

VII. *Decomposition of the Citrate of Lime by Sulphuric Acid.*

To expel the carbonic acid completely from 4 ounces of chalk, it was necessary to employ 20 ounces of diluted sulphuric acid (of 19 degrees of Baumé's areometer). This acid is made by mixing three parts of water with one of common oil of vitriol: if the latter is not well concentrated, the water must be diminished, and, by some trials, the diluted acid may be brought to the required point.

To separate the citric acid united to a base of four ounces of chalk, it is evident that the above quantity of sulphuric acid must be sufficient. This quantity, therefore, amounts to five times the weight of the citrate, or 500 per cent. of this earthy salt.

I heated to ebullition six ounces of citrate with two pounds of water, and added 30 ounces of my sulphuric acid of 19°: after being exposed to ebullition about seven minutes, taking care to stir the mixture with a spatula, the whole citrate was found changed into a calcareous sulphate. The mixture being then strained through filtering paper, and left to evaporate, deposited sulphate; and four successive evaporations and filtrations were necessary to free it entirely from its earthy deposits.

The separation of this sulphate may be abridged by mixing the liquor, evaporated to the consistence of bright syrup, with a certain quantity of spirit of wine; and this is even the process which ought to be followed on all occasions when it is required, without having a very large quantity of citric acid, to obtain it as pure as possible.

The consistence of bright syrup is not, however, the point at which the citric acid can crystallize, it must be carried to that of baked syrup, because this acid takes up very little water in its crystals. By two crystallizations I obtained $3\frac{1}{2}$ ounces, or 28 drams, of pretty large crystals. The two drams wanting

wanting to complete the thirty, which, according to the proportion before eſtabliſhed, ought to be produced by ſix ounces of citrate, remained in the mother water. But, as it appeared to me that there could not be more than half a dram in this reſiduum, it is evident that the citric acid will be, as I have before indicated, from two to three below 70 per cent.

VIII. Though the citrate of lime be white and well waſhed, it always retains fixed in it a little extractive matter, the colour of which is found again, after its decompoſition, in the liquors. It thence happens that it is difficult to obtain the cryſtals white without two new cryſtallizations at leaſt. The citrate of lime, in this reſpect, exhibits the ſame phænomena as the other earths and earthy ſalts, which readily adhere and fix themſelves to the colouring parts. The citrate, which may be ſeparated from the juice of verjuice by chalk, is, in particular, attended with this inconvenience:—if it be not immediately ſeparated from the liquor, it aſſumes a violet colour, which cannot be taken from it by repeated waſhings.

Four ounces of lemon juice employed in the ſucceeding experiments, evaporated in the ſun, left 48 grains of dry reſiduum. But the citric acid, having been found to be 34, the extract, gum, and a little malic acid, formed together 14 grains. Theſe 48 grains, of different principles, were then diluted in 3 ounces 7 drams and 24 grains of water; that is to ſay, they formed a ninety-fourth of the lemon juice.

IX. *Conſequences.*

It follows, from theſe reſearches, that mucilage and extractive matter, as Scheele diſcovered, are the corruptible or fermentable principles of the lemon juice; and as none of the recipes propoſed for its concentration are capable of depriving it of theſe principles, it is neceſſary to have recourſe to the method of that author. This method will be very practicable on a large ſcale, but it will require baſons of ſilver or fine tin. It will be abſolutely neceſſary to proſcribe from the laboratory earthen veſſels varniſhed with lead, but not ſtone ware, becauſe the lead which enters into their coating is ſo far vitrified as to be proof againſt any attack. One can hardly believe that the ſyrup of lemons commonly ſold in the ſhops does not contain oxide of lead. Hepatic water gives to theſe ſyrups a dark brown colour. This is ſufficient to convince us that either lead or copper is preſent.

Let us now conſider ſeparately each of the principles of our lemon juice in regard to fermentation.

Strictly ſpeaking, none of them is capable ſeparately of paſſing to ſpiritous fermentation, and not even to the acetous.

The extractive part of this juice tends very rapidly to mouldiness. Notwithstanding this, when they are found naturally mixed with saccharine juices, such as that of grapes, apples, cherries, elder berries, &c. they pass very well to a new state, which to them, if it be not that of spiritous fermentation, is, however, a state which ensures common preservation to all the principles. Let us take, for example, the juice of gooseberries, one of those juices which, on account of their excess of acid, produce only bad wine, poor in spiritous product.

This juice is composed of mucilage, gelatine, extract, sugar, citric and malic acid, &c. If it be made to ferment during warm weather it goes on but faintly, because it does not contain a sufficient quantity of sugar, which is the basis of spontaneous movement; but if this deficiency be supplied by adding from one to two ounces per pound, it may be brought to produce real wine; but *green wine* indeed, because the acid principle, which predominates in this juice, will not allow us to expect any thing else. In a word, the juice of gooseberries may serve to represent the juice of those grapes which have been deprived of sweetness and maturity by a rainy and cold season.

In this wine, and all those of the same kind, it appears that the primitive acid is not altered, or at least is less sensibly altered, by fermentation; so that, if the quantity of citric acid it contains before fermentation be appreciated, it may be found entire after the fermentation is over: and it is very probable, also, that the gummy and extractive parts will no longer be found, or will be found in a very inferior proportion.

Now, if instead of checking the spiritous fermentation of the juice of gooseberries, it be speedily brought to the acid fermentation, I have no doubt that it might be possible to obtain vinegar of gooseberries, the mucous and acetified extractive parts of which would be as little susceptible of further alteration as those which enter into the composition of every kind of vinegar, which, in my opinion, support very well the heat of the line.

According to these ideas, it would be proper to prepare lemon juice for fermentation by the addition of a small quantity of sugar, to carry this fermentation to its maximum of acescence, and to subject the vinegarized juice first to a chemical analysis, if possible, and then to a trial at sea. Who knows but the citric acid might be found entire after the fermentation, as is the case with tartar? and, whether freed from the greater part of those principles which, as has been

already ſeen, form an obſtacle to its cryſtallization, it might not be poſſible to complete its purification either by concentration alone, or by the aid of a little ſpirit of wine? Experiments of this kind ought to be undertaken in a warm country, and on a ſomewhat large ſcale, if it be required to obtain more certain reſults than thoſe which I was able to obtain in Caſtille.

As the citric acid, when cryſtallized, poſſeſſes a very active acidity, it appeared to me of importance to compare lemonade made with theſe cryſtals with that made by uſing the freſh juice. I therefore firſt took the juice of a lemon, and endeavoured, by repeated trial, to diſcover what quantity of it in weight it would require to make a large glaſs of lemonade well ſeaſoned with ſugar. The quantity requiſite was about eight or nine drams.

We have already ſeen that an ounce of juice employed for experiments contained about 34 grains of citric acid, with a ſmall portion of malic acid. I therefore made a glaſs of lemonade, of the like ſize, with the ſame doſe of ſugar and 54 grains of citric acid. The lemonade was of ſuch a nature that thoſe called in to compare them could find no difference, except that there was ſomething more agreeable in the latter than in the former. At firſt they could not tell in what this difference conſiſted; but each of thoſe preſent having taſted them ſeveral times, it was at length agreed that the firſt lemonade has a ſlight harſhneſs not obſerved in the lemonade made from the citric acid.

This difference was aſcribed, and very properly, to the ſmall quantity of aſtringent principle in the lemon juice. The addition, indeed, of ſome drops of iron in freſh lemon juice, ſaturated afterwards by potaſh, made it aſſume that vinous colour which is obſerved in old lemon juice.

It is to the aſtringent part of the lemons, without doubt, that we muſt aſcribe that contraction of the abdomen which people very often experience after drinking lemonade. Hence it follows, that in diſeaſes where this contraction is to be apprehended, lemonade made with citric acid ought to be preferred.

I ſhall conclude this memoir with the means of preventing an accident which may take place in the proceſs followed in regard to the citric acid.

If more ſulphuric acid than is neceſſary to ſaturate the baſe of the citrate has been employed, when this acid has concentrated itſelf by evaporation, it will react on the citric acid, and proceed ſo far as to ſeparate ſome carbonaceous principles; the mixture, becoming blacker and blacker, will

refuſe to give cryſtals. This exceſs may be remedied by throwing a little chalk into the mixture, after being heated, and then filtrating it to ſeparate the ſulphate of lime which has been formed. With a little practice it will be eaſy to fix the point at which the ſulphuric acid is nearly ſaturated, in order that the citric acid may not be neutralized alſo.

XX. *Conjectures reſpecting the Origin of the American Nations* *.

WHETHER America, called alſo the Weſt Indies and the New World, was known to the antients, is a queſtion which, after long being an object of reſearch, has never yet been decided. The Egyptian prieſts, as we are told by Plato, gave an account to Solon, the Athenian legiſlator, of a certain iſland called Atlantis, which was ſituated at the diſtance of a few days ſail from Spain beyond the ſtrait of Gibraltar. This iſland, according to the information given by theſe prieſts, was greater than Libya and all Aſia, properly ſo called, taken together; and ſo powerful, that it had reduced under its dominion all Libya as far as the Tuſcan ſea, till it was at length ſwallowed up by a flood and violent earthquake, which continued twenty-four hours. Diodorus Siculus alſo ſpeaks of a large iſland to which the Phœnicians were driven while cruizing along the eaſtern coaſt of the Atlantic. He ſays alſo that the Tuſcans, who at that time were powerful at ſea, were deſirous of ſending thither a colony, but were prevented by the Carthaginians, who wiſhed to preſerve this iſland to themſelves as a place of refuge in caſe of neceſſity, and for that reaſon endeavoured to conceal it from the whole world.

Had the large Atlantic iſland been mentioned by no other writer beſides Plato, the whole account might have been conſidered as a fabrication or an allegory; but the teſtimony of Solon, or at leaſt of the Egyptian prieſts, gives it a certain air of authenticity. In regard to Diodorus Siculus, his in-

* From *Neue Nordiſche Beytrage*, by profeſſor Pallas, vol. iii. Reſpecting the author profeſſor Pallas adds the following note:—"I have thought it neceſſary to publiſh this almoſt forgotten and not unimportant eſſay of the late profeſſor H. Fiſcher, of the Peterſburgh Academy, which was firſt made known in the St. Peterſburgh *Hiſtorical Calendar*, becauſe it has been miſapplied by a writer, who has been guilty of other plagiariſms from his works, without mentioning the real author, to whom he has been indebted for many of the obſervations he has given out as his own. It is hardly neceſſary to ſay, that this paper of profeſſor Fiſcher, which was firſt publiſhed in 1771, forms the foundation of Scheerer's work on the Peopling of America, publiſhed in the French language.

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formation, as mentioned in his work, was taken merely from tradition or fabulous relations, which will not bear critical examination. But even though this account were true, the iſland of Diodorus might be conſidered as one of the Canary iſlands, or perhaps Ireland or Britain, as the ſhip is ſaid to have been driven thither by a ſtorm.

It is not, however, our intention to dwell on this ſubject, as our object is to examine at what time and from what place the Americans were conveyed to that country which they now inhabit. In the firſt place, then, one of the three following poſitions muſt be admitted as true: The Americans are aborigines, that is, original inhabitants who have always been in poſſeſſion of the country; or they have emigrated thither from ſome other part of the globe; or they have ſerved to people our old world with their colonies. Were we not aſſured of the contrary by the Scripture, the firſt and laſt of theſe poſitions might be defended as well as the ſecond. Among the Pagan philoſophers, the diſpute reſpecting the creation or eternity of the world was never decided; and many of the nations of antiquity, ſuch, for example, as the Athenians, boaſted of being deſcended from no other people. In regard to the third poſition, the Mexicans actually believed that the Spaniſh kings were deſcended from their firſt ſovereign Quezalkoal, and conſequently they had made themſelves maſters of Spain ſeveral hundred years before the diſcovery of America. This, however, does not agree with what is recorded in hiſtory; and the Mexicans, in this reſpect, were dupes to the ſame vanity as many other nations, who pretend that all the ſciences, knowledge, inventions, and political inſtitutions in the world were tranſmitted by them to the reſt of mankind. To give only one inſtance, many of the learned in Europe have imagined that Pythagoras communicated his idea of the tranſmigration of the ſoul, and the Egyptians their political conſtitution, to the Indians; though Pythagoras and all the other Greek philoſophers derived their wiſdom from the Indians, and by no means communicated theirs to them. Whether the Indians had their learning and political knowledge from the Egyptians, or the latter from the former, is a queſtion which many of the moderns think ſcarcely worthy of an anſwer; becauſe they have read accounts given in Greek works, or the accounts of the Roman authors collected from the Greek writers, who pretend that the Egyptians were in every thing the predeceſſors and inſtructors of the Indians.

I have mentioned the firſt and third poſition, not becauſe I conſider them as true, but only to ſhow that, however falſe

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an opinion may be, it will ſtill find defenders: the ſecond poſition, therefore, alone remains to be examined, viz. that the Americans were tranſplanted to their preſent country from ſome other part of the world.

Not only the divine revelation, by which we are expreſsly taught that the firſt men originated in Aſia, but the natural indolence, dulneſs, and want of all the arts and ſciences among the Indians—compared with the genius, livelineſs, and induſtry, of the nations in other parts of the world, leave no doubt that the Americans never went out of their own country to a foreign one; and, on the contrary, that foreign nations viſited them. But what nations, and how? Was it on purpoſe, or by accident? Theſe are difficult queſtions, the ſolution of which would require more than common knowledge of the languages in every part of the world; of the features of the natives, and their religion, manners, cuſtoms, and uſages. It is not requiſite, however, that one ſhould be acquainted with all the languages in the four quarters of the globe; it would be ſufficient, at firſt, that one ſhould be able to compare the languages on the weſtern coaſt of Africa with thoſe of the different countries of America, ſuch as Brazil, &c. But, though this would require great labour, it is not impoſſible that a vocabulary containing ſome hundred words in all the known languages of the world might be collected. Condamine coincides with my opinion when he ſays, that this, perhaps, is the only method of diſcovering the real origin of the Americans. Such a vocabulary would be much fitter for the purpoſe than the Lord's prayer, which has been tranſlated into the languages of ſo many ſavage nations; for, as the ſavages have few or no words expreſſive of moral or metaphyſical things, how can this prayer be properly tranſlated into their languages? Beſides, in learning any thing, people ought always to begin with the eaſieſt part, and to conclude with the moſt difficult; but here the order preſcribed by nature is reverſed.

In regard to ſuch a vocabulary, if, among ſome hundred words, a few ſhould be found ſimilar both in ſound and ſignification to one of ſome other language, one ought not thence to conclude that theſe two languages were the ſame. Who, for example, will ſay that the Latin and Greenlandic languages have an affinity, becauſe the Greenlandic word *ignach* has the ſame meaning as the Latin word *ignis*, fire*?

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* The ſame thing might be ſaid of the Shanſcrit, which contains a great many words that both in ſound and in meaning have a ſimilarity to the Latin. For example, *dendha*, dens, a tooth; *yuga*, jugum, a yoke; *juncta*, junctus, juncta, junctum, joined; *nau*, navis, a ſhip; *nà-vïga*,

On the other hand, there are people who, though they find many words in the languages of two nations which have conſiderable ſimilarity and the ſame ſignification, will not acknowledge the ſimilitude. Theſe, however, are in the wrong, becauſe they do not take into conſideration the way in which different nations pronounce their words, either by ſhortening or contracting them; and do not reflect that every nation has in its alphabet peculiar characters which others have not, and which they cannot pronounce; from which there muſt naturally follow a perceptible variation in the ſound of two words of the ſame meaning.

Such a general collection of words might require, perhaps, one or more centuries; and if no other way can be found for diſcovering the origin of the Americans, our reſearches by this method will, in all probability, prove fruitleſs; for hiſtory, or rather tradition, affords us no light in this reſpect, and, in my opinion, hiſtorians have never given themſelves much trouble reſpecting it. There is however another method of attaining to the propoſed end; that is, by comparing the manners, cuſtoms, and mode of life among the Americans, with the manners and cuſtoms of other nations. It is indeed true, that two nations very remote from each other may have a great ſimilarity in their manners, cuſtoms, &c. without being ſprung from the ſame ſtock; but when ſingular practices, which appear to be contrary to nature, are found among different nations, they muſt either have been invented there, or been borrowed from others. The firſt caſe ſeems not very probable, for it can hardly be comprehended how ſuch ſingular ideas could have ariſen among individuals, and much more among different nations; it is therefore probable that theſe people have communicated their ſingular manners and cuſtoms to each other by their common intercourſe.

We ſhall therefore examine the origin of the Americans on theſe principles, and conſider, as briefly as poſſible, their ſingular mode of life, together with the moſt remarkable of their manners and cuſtoms, ſo far as they coincide with thoſe of the old world.

1. *Singular Form of Government.*

In the Eaſt Indies, the Samorin, that is, the ſovereign of the kingdom of Calicut, was ſucceeded not by his own ſon but by the ſon of his ſiſter. This manner of ſucceſſion is common alſo in all the ſtates of Malabar. The princes do

viga, navita, navicularius, a ſhipmaſter; *nava*, novem, nine; *ſapta*, ſeptem, ſeven; *tri*, tres, three; *dui*, duo, two; *adja*, hodie, to-day; *vidhava*, vidua, a widow; *nò*, non, no; *ſua*, ſuus, his, &c. See Fra Paolino's *Voyage to the Eaſt Indies*, p. 316.—EDIT.

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not marry princeſſes, but the daughters of nairs; and therefore their children are not princes, but nairs. The princeſſes are generally given in marriage to bramins: all the children produced by ſuch marriages are princes, and capable of ſucceeding to the throne. This princely race forms the royal family, which takes the precedency of all the reſt. After the king's death, the oldeſt prince always ſucceeds him in the government. By this method, no diſputes ariſe in regard to the ſucceſſion, and young ſovereigns are never ſeen. In all the countries inhabited by negroes, from Senegal to the Rio Volta, the king is always choſen from the royal family; but his children are uniformly excluded from the ſucceſſion, which in all caſes goes to the female branch.

In America, and the iſland of Hayti, now called St. Domingo, the principalities were hereditary; but when the cacic died without heirs, his poſſeſſions devolved to his ſiſters' children, to the excluſion of the brothers' children.

On the death of the chief of the Iroqueſe, his dignities always fall to the children of his mother's ſiſter.

Theſe cuſtoms are followed alſo by the Hurons, the Natches, and the Indians on the Miſſiſſippi. They ſay that one can depend with more certainty on the ſiſter's ſon being of the royal blood, than on the king's ſon, or the ſon of his brother.

2. *Interring the Dead.*

We find inſtances both in antient and modern hiſtory of wives and ſlaves being interred along with the body of a deceaſed prince or great man. Herodotus, ſpeaking of the Scythians on the Boryſthenes (Dnieper), ſays, that on the death of their king, one of his concubines, his cup-bearer, cook, purveyor, valet, &c. together with horſes and golden cups, were interred along with him. We are told the ſame thing by Lucian. The Romans, at the funerals of great men, ſacrificed a number of priſoners, who were obliged to fight in ſingle combat till none of them remained. Cæſar relates, that among the Gauls, the Soldurii ſhared with their patrons in all the conveniences of life and the bitterneſs of death. In another place he ſays, that the cuſtom of burning the ſervants and deareſt clients of great men at their funerals, together with other things, had ceaſed not long before that period. The antient Danes, to ſhow their reſpect for the dead, cauſed wives to be buried alive with their huſbands. We are aſſured by Dalin the hiſtorian, that the ſame practice prevailed alſo in old Sweden. We are informed by De Guignes that it was cuſtomary among the Honi-Re, a Turkiſh nation, to inter with their huſbands thoſe wives who had brought

brought them no children; and even at preſent, the women in the Eaſt Indies ſometimes burn themſelves along with their deceaſed huſbands. Marco Polo relates, that, when the chan of the great Moguls was conveyed to the place of interment, all thoſe who met the proceſſion on the road were put to death, in order that they might ſerve the great chan in the other world. In the barrows, which were the burying-places of the old Moguls, there are found ſometimes around the body, lying in the middle of them, other bodies, which probably were put to death at the funeral. It was cuſtomary among the Jakuts, whoſe anceſtors ſerved in the armies of the Mogul chans before they were ſubjected to the Ruſſian government, that one of the favourite domeſtics of the deceaſed ſhould burn himſelf, with every mark of joy, in a particular fire made for the purpoſe, that he might ſerve his maſter in the other world. This practice muſt have been cuſtomary, alſo, among the Mantchew Tartars; for Duhalde ſays, that Schnu-tehi, the founder of the family now on the throne of China, after he had loſt his ſon and princeſs, required that thirty perſons ſhould expoſe themſelves to voluntary death in order to appeaſe the ſouls of the deceaſed; and that Cham-hi, his ſucceſſor, had taken a great deal of pains to aboliſh this cuſtom. Among the Afgans, a piratical people on the borders of Perſia, and the inhabitants of the Philippine iſlands, a ſimilar cuſtom prevailed. At the interment of the kings of Whidah and Benin, a great many perſons of both ſexes are thrown into the grave alive. Theſe kingdoms lie on the weſtern coaſt of Africa, which of all countries in the old world are neareſt to the eaſtern coaſt of America.

In the iſland of Hayti, at the interment of the caeic, many perſons of both ſexes, but in particular ſome of his wives, were buried alive with him; and they often contended among themſelves for having this honour.

The Caribs ſtill put to death their ſlaves on the deceaſe of their maſters. This deteſtable cuſtom was conveyed from theſe iſlanders to the Mexicans and Peruvians, and even to the Natches on the Miſſiſſippi.

3. *Cutting off the Hair as a Mark of deep Mourning.*

This was a very old cuſtom among the heathens, which God, through Moſes, forbade the children of Iſrael to imitate. At firſt, the hair of dying perſons was cut off, for it was ſuppoſed that their ſouls would otherwiſe not be received into the kingdom of Pluto. Of this we have two celebrated examples in Alceſtes and Dido. In the courſe of time the relations alſo cut off their hair as a mark of ſorrow.

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The Scythians on the Boryſthenes, according to the teſtimony of Herodotus, cropped their hair on the interment of their kings. This offering to the dead is often mentioned both by the Greek and Latin poets; for ſuch is the name given by Ovid to this ceremony, when he ſays that Hecuba left her tears, together with her gray hairs, on the grave of her ſon Hector, as an offering to the dead. Petronius, ſpeaking of the well-known matron of Epheſus, ſays that ſhe placed the hair torn from her head on the breaſt of her deceaſed huſband. Buſbek, ambaſſador from Ferdinand king of Hungary to Soliman the Turkiſh ſultan, ſays, that tufts of human hair are found on the graves of moſt of the Servians, as a mark of the ſorrow of the relations for the loſs of the deceaſed. Though the Servians are not now heathens, but Chriſtians, and, conſequently, theſe tufts of hair can no longer be conſidered as an offering to the dead; yet conſtant experience ſhows, that in all the changes of religion which take place among nations, ſome remains of the old religion are always retained.

Inſtances of this practice may be found even in modern times. In the year 1716, one of the Chineſe embaſſy, having died at Samarow-jam, a ſmall town at the mouth of the river Irtiſh, his oldeſt domeſtic cut off a lock of hair from his head, and threw it into the funeral pile as an offering to the deceaſed. The mataram, ſupreme prince of the iſland of Java, when he cauſed his rebellious brother to be interred with great funeral pomp, as a token of his grief cut off his hair. The Caribs in the Antilles crop their hair when in mourning, and the women cut it off entirely. The women in Virginia ſtrew their hair around the burying-ground, or throw it upon the grave. The Brazilian women ſhave their heads, and their mourning is not at an end till their hair has grown again. When the Apalachites, a people of Florida, are deſirous of expreſſing their ſorrow for the death of a relation, they cut off a part of their hair: at the death of their prince they ſhave their heads entirely, and do not ſuffer their hair to grow again till the body has been depoſited in the earth, which is never done till the expiration of two years.

The Iroqueſe of both ſexes teſtified their grief alſo by cutting off their hair. The women, on this occaſion, durſt not go out of their huts till their hair had grown again; but as this required a long time, they at preſent, with the permiſſion of their relations, cut off only a ſmall portion, which they ſtrew over the graves of their deceaſed huſbands. It is here to be obſerved, that the women in Canada conſider it as the greateſt indignity that can be offered to them if any one cuts off their hair;

hair; for in this condition they dare not appear in public. Among the men, ſhaving the beard is uſual; as was the caſe with the ambaſſador from the Turkiſh ſultan Bajazet to Tamerlane.

4. *Deſtroying the Habitations and Huts of the deceaſed.*

The antient Moguls were accuſtomed to tear to pieces and deſtroy the tents of their deceaſed officers. The preſent Moguls, alſo, when their chan or his principal conſort dies, if they are private perſons, abandon their habitations; and the chief of the tribe leaves his camp, and never ſuffers himſelf to be ſeen during the whole period of mourning. Among the Telengutians, the huts of the deceaſed are deſtroyed. The Jakutians formerly removed from the huts in which any one died, and entirely abandoned them. The Telengutians are a race of the Urats or Oelots, who together are called Calmucks; and the Jakutians, as far as can be concluded from their language, are of Tartar extraction. Both of them may have inherited this cuſtom from the Moguls. The Perſians have an averſion to the habitations in which their fathers have died, and never approach them. No one, alſo, will reſide in the houſes or palaces of the great officers put to death by order of the ſovereign, or ſchah; for this would be conſidered as an unfortunate omen of a ſimilar fate; and therefore ſuch houſes generally ſtand empty, and ſoon fall into ruins. No ſooner has a Laplander breathed his laſt, than his neighbours drag out the body and deſtroy the hut, which they afterwards abandon. On the death of the king of Whidah, on the weſtern coaſt of Africa, his palace is deſtroyed, and another, according to the taſte and pleaſure of the new ſovereign, is erected.

Among the Caribs it is cuſtomary alſo to deſtroy the hut in which the father of a family has died, and to build another in ſome other place: nor does any one ever think of rebuilding the former one. In Peru, the apartment inhabited by a deceaſed inca was cloſed up by means of a wall.

This averſion to the habitations of perſons deceaſed ariſes from a ſuperſtitious notion, prevalent among the pagans, that the deceaſed in the other world follow the ſame occupations which they exerciſed during life, and that therefore they have occaſion for every thing they before poſſeſſed. For this reaſon, their furniture, utenſils, and tools, are thrown into the grave along with them. Should any of theſe articles be withdrawn or withheld, the ſpirit of the deceaſed, according to the idea of theſe people, would have no reſt, but torment and frighten the living by its appearance. They conſequently

chooſe

chooſe rather to remove to a diſtance, and to leave to the reſtleſs ſpirit the whole hut, in which they imagine it reſides, or elſe they deſtroy it. The very thought, therefore, of a deceaſed perſon is diſagreeable to theſe people; his name is never uttered; and if any perſon of the tribe has the ſame name, he is obliged to lay it aſide, and to aſſume another. In this manner, a deceaſed perſon among them is like one who never was in the world; his hiſtory and genealogy cannot, therefore, be far extended.

5. *Huſband aſſuming the Place of his Wife when delivered of a Child.*

We are told by Strabo, that the men in the northern part of Spain, after the delivery of their wives, went to bed, and ſuffered themſelves to be nurſed by them. This cuſtom ſtill exiſts in ſome of the provinces of France bordering on Spain, where it is called making a *couvade*. The ſame thing is related by Diodorus Siculus of the Corſicans, and by Apollonius Rhodius of the Tibarenes, a people inhabiting the coaſt of the Pontus Euxinus, in Aſia Minor. Marco Polo, ſpeaking of a province which in the French tranſlation is called Areladam or Ardandam, ſays that the women left their bed as ſoon after delivery as poſſible, and that the men then took their place, where they remained for forty days, and nurſed the new-born child. This cuſtom is ſaid to be uſual, alſo, among the Japaneſe.

When the Carib women in Guiana are delivered, the men bind up their head and place themſelves in bed, as if ſeized with the pains of labour. They are then viſited by their neighbours, who conſole them by all thoſe means uſual among theſe people. This cuſtom muſt always be ſtrictly obſerved; for, even when engaged in war, as ſoon as they hear of the delivery of their wives they muſt return home. We are told by Labat, that the father of the child, on this occaſion, muſt obſerve a ſtrict faſt for thirty or forty days; but he adds, that this ceremony is practiſed only in regard to the firſt-born, otherwiſe, ſays he, the poor huſbands, who have five or ſix wives, would be obliged to keep more faſts than the Capuchins. This account is confirmed by Fermin in his deſcription of Surinam, but he ſays nothing of the ſtrict faſting which muſt be obſerved by the father of the child. Piſo, a Dutch phyſician, ſays, that the women among the Brazilian ſavages, when they find the pains of labour approaching, go out into the woods to cut the umbilical cord of the child with a ſhell, which they boil and eat; and that the huſbands, in the mean time, go to bed and uſe the beſt food

they

they can procure, under a pretence of repairing their loſt ſtrength. We are told the ſame thing by captain Woods Rogers, who ſays that the Brazilian women, at the time of their delivery, go out alone into the woods, and when delivered waſh the child; while the men place themſelves in bed for twenty-four hours, where they are attended in the ſame manner as if really ſuffering from the pains of labour.

Laſitau denies that the men indulge themſelves on this occaſion, and is of opinion that this practice is a religious ceremony, which muſt be performed for ſix months with the ſtricteſt faſting, and other acts of mortification almoſt inſupportable; and that it ought to be conſidered as a kind of penance for the ſin of our firſt parents. If this be true, the notion of original ſin muſt be diffuſed throughout the whole world, and have been conveyed from the old to the new continent: but this I ſhall not here examine. He, however, agrees with Labat in ſaying that this ſtrict faſting is obſerved only in regard to the firſt-born child; but, inſtead of ſix months, as above mentioned, Labat makes the duration of it to be only thirty or forty days.

[To be continued.]

XXI. *Reſearches reſpecting the Laws of Affinity. By* C. BERTHOLLET, *Member of the French National Inſtitute.*

[Continued from p. 74.]

XIII. On the Precipitation of Metallic Solutions by other Metals.

1. WHEN metals are precipitated by ſubſtances which do not ſeize upon their oxygen, the precipitates retain a portion of the acid, and often ſome of the precipitant. Of this we have a ſtriking inſtance in the precipitate of the oxygenated muriate of mercury by the alkalis and lime. On expoſing the precipitate to a ſufficient heat, one portion of mercury, more or leſs conſiderable, according to the nature of the precipitate, is reduced, another is ſublimed, and forms a muriate, not merely becauſe the muriatic acid is combined with a portion of the oxide of mercury, as I ſuppoſed, (*Memoirs of the Academy*,) but becauſe the expanſive force of the heat, and the tendency to the combination of the muriatic acid, acting upon the oxide of mercury, cauſe, as we may ſay, a new partition of it to be made: the precipitate by ammonia retains a portion of the ammonia; the precipitate of

the muriate of iron by potash, retains part of the potash. Facts of this kind may be collected in great number. There is no doubt, therefore, but that the observations which have been made upon the precipitations of substances which lose their solubility, cannot be applied to the metallic precipitates, which vary according to all the circumstances which are capable of modifying the powers brought into action, at the moment of their successive precipitation, and which will deserve a particular examination in another memoir. But when the metals are mutually precipitated from their solutions, their reciprocal affinity for oxygen has a great effect in the action that takes place; and sometimes the precipitate is found in the metallic state. If another force were not joined to the affinity of the precipitating metal for oxygen, it would naturally follow, from the principles established in this memoir, that the oxygen would divide itself between the two metals which are in competition, according to the action they exert upon it. It is therefore necessary to examine what may be the force which determines the precipitation in the metallic state.

2. The affinity of mercury, gold, and silver, for oxygen, is very weak: the mutual affinity which still remains between the parts of these metals when they are in fusion, as mercury is at the temperature of the atmosphere, is sufficient to prevent their combination with oxygen in the state of gas; but heat, by dilating the particles of the mercury, diminishes the force of their mutual affinity sufficiently to enable them to combine with oxygen; while a superior degree of heat, by the difference of dilatation which it produces in the mercury and in the oxygen, will separate them: heat, then, contributes to this combination by diminishing the mutual affinity of the parts, but at length, by augmenting this difference, it renders their combination impossible. As the force of cohesion in mercury is sufficient to prevent oxidation, this very force will tend to effect its deoxygenation, with the assistance of a metal which will act directly upon the oxygen. It is a force analogous to that which produces crystallization and precipitations. (Art. V.)

3. The particles of a metal have not only a mutual affinity, but likewise an affinity for those of other metals: hence proceed the amalgams and mixtures. It is only necessary to put copper in contact with mercury to effect a combination between these two metals. Thus, when a metal opposes its action to a metallic solution, part of the metal may act upon the oxygen and upon the acid, while the other tends to combine with the metal of the oxide. Let us see whether we can

discover,

diſcover, in the precipitation of the mercury, ſilver, gold, and copper, in the metallic ſtate, the influence of theſe two forces, that is to ſay, the mutual affinity of the particles of one and the ſame metal, and the affinity of one metal for another.

4. When a piece of copper is put in a ſolution of mercury in nitric or in muriatic acid, the copper becomes inſtantly white, and the mercury is revived, but combined with the copper. If, inſtead of copper, a plate of clean iron be plunged in the ſame ſolution, after ſeveral hours the liquid appears diſturbed, and at length a precipitate is formed; but with the muriatic ſolution in particular, this precipitate is partly in the ſtate of an oxide, and very probably retains a portion of acid.

If the affinity of one metal for oxygen were the ſole cauſe that produced the precipitation of another metal, the iron ought to act with greater efficacy than the copper; for it is known to have a ſtronger affinity for oxygen: but its action is ſlow, difficult, and incomplete, while that of copper is inſtantaneous. It is ſeen by the manner in which the indecompoſable acids are retained by the oxide of copper and the oxide of iron, when theſe combinations are expoſed to the action of heat, that there can only be a very ſmall difference between the affinities of theſe metals for the acids. There is conſequently no doubt that the affinity of the copper for the mercury, with which it has actually combined, muſt have greatly contributed to its precipitation in the metallic ſtate; but in the experiment with iron, the mutual affinity of the particles of mercury muſt alone have decided, though with difficulty, the reduction of the mercury; a portion was alſo precipitated in oxide, and probably retained a portion of acid, as the whole would have done, if the affinity of the iron for oxygen had been the ſole agent; and the portion precipitated in the metallic ſtate did not combine with the iron.

5. If a ſolution of ſilver be precipitated by copper, the precipitate, which is in the metallic ſtate, is not pure ſilver, but a combination of ſilver with a ſmall portion of copper: it could not take the copper from the plate itſelf, which was plunged in the ſolution; it muſt therefore have precipitated with it out of the ſolution: the mutual affinity of theſe two metals decides their deoxygenation. By means of this force, two combinations are effected, as often happens: one, that of the acid with the oxide of copper; the other, that of the ſilver with a portion of the copper. The action of the acid upon the oxide of copper, and that of ſilver upon copper, are thus put in equilibrio.

6. In like manner, if a plate of copper be plunged into a ſolution of gold, the gold which is precipitated, ſhows, by its

deeper colour, that it has combined with copper, and the solution retains but a small part of the copper lost by the plate. If a plate of iron be put in this solution, the gold which is precipitated seizes, perhaps as strongly as in the former case, a part of the iron, or at least its precipitation is determined by the affinity of the iron for the gold, at the surface of which this last combines. For the gilding is a combination of the two metals at the surface of contact: when the first stratum is formed, the precipitation is afterwards capable of continuing by the mere force of the mutual affinity which the particles of gold have for each other, and which makes them to cohere.

7. What I have just stated is proved in the precipitation of copper by iron. When a solution of copper is decomposed by a plate of iron, and the copper attached to the plate is separated, it is perceived, by the brown colour of the interior surface, that the copper is not there pure, but contains some iron. After this first stratum the copper continued to precipitate by contracting an adherence with itself, and afterwards with those coats which are successively formed: the affinity, then, for the iron began the effect, which was continued by that of the copper for itself.

8. Phosphorus precipitates several metallic solutions, as has been explained by Sage and Bouillon (*Journal de Physique* 1781). Though it has a strong affinity with oxygen, yet what has just been explained relative to precipitation by the metals, ought to be applied to its action. Pelletier has proved that phosphorus has the property of combining with metals, so that a part of that which is put in action is capable of combining with oxygen, while the other acts equally upon the metal. There are some metallic solutions which are not affected by phosphorus; in others the metal is precipitated in oxide, which doubtless retains part of the acid of the solution, or of the phosphoric acid which is formed; in others the metal is at length reduced. Gold, silver, copper, and mercury, are among those which resume the metallic state. On considering the observations which have been made on this precipitation, it appears that copper and silver are precipitated by combining with a small portion of phosphorus: thus, in precipitating twelve grains of silver, three grains of phosphorus are consumed; but only about three grains of phosphoric acid, in a gelatinous state, are obtained: now, only one grain of phosphorus is necessary to produce this quantity of acid; consequently, more than two grains must have combined with the silver. A part only of the mercury, thus treated, resumes the metallic state; the rest preserves the state of an oxide, and combines with the phosphoric acid. Here

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the force of cohesion is weak, and no combination is made with the phosphorus; hence the effect is but partial, as when iron is used. (No. 4.)

Though the affinity of gold for oxygen is much inferior to that of copper, its precipitation is not so quickly effected, and a portion is precipitated in the state of oxide; probably because it has little disposition to combine with phosphorus; and it is the combination of copper with phosphorus that determines the precipitation of the latter metal. Some of the observations which I have here presented, require the accuracy of experiment for their entire explanation: but all appear to me indubitably to prove that it is the force of cohesion which tends to recombine the particles of one individual metal, and the mutual affinity of some metals which decides their precipitation in the metallic state; so that this state is more or less sudden and complete, according to the force with which these causes are capable of acting *.

XIV. On the resulting Affinity.

1. The result of the action of several affinities in the same substance, I denominate the *resulting affinity:* for instance, the nitric acid is composed of oxygen and azote; this acid combines with potash; it acts upon potash by an affinity resulting from that of the oxygen and of the azote. The reciprocal mutual action of the potash is likewise a force resulting from that exerted by it upon each of the substances which compose the nitric acid.

2. All bodies existing upon the earth have an affinity for each other. If there be exceptions, the number can be but very small. I may therefore reason from this, and apply to all substances that which observation has made known relative to affinities and their modifications. If this application be not forced, if it accounts for properties which cannot be directly established upon experiment, the considerations which I present in this article may throw some light upon several phænomena, which are owing to a chemical action still undetermined.

3. In the definition of *resulting affinity*, I have supposed that the affinity of a compound substance is derived from those of the substances which compose it. It is necessary to examine what circumstances may modify the elementary affinities, and to ascertain the changes which must arise in the affinity resulting from them.

* Fabroni has published some very interesting observations on the mutual action of metals. (*Journal de Physique*, Brumaire, an. 8.)

4. The chemical action of substances is weakened in proportion to their saturation. (Art. II. No. 10.) It must be concluded, therefore, that the resulting affinity must be a less quantity than the elementary affinities when alone: for the latter have experienced a commencement of saturation; but other circumstances may increase the action of the resulting affinity, or may augment the weakness it derives from saturation.

5. If one of the substances that combine change from a solid to a liquid state, it acquires the advantages possessed by solvents; and its affinity, before disguised by the solid state, becomes active; so that the resulting affinity may, on this account, be much more considerable than the elementary affinities appeared to be. Thus, when sulphur is dissolved by potash, the sulphuret which proceeds from it exerts a strong action upon oxygen gas, as soon as it has been rendered liquid by the addition of water, or has attracted sufficient humidity from the air: because it has by that means lost its force of cohesion, as it would by igneous fusion; and because the potash likewise exerts an action upon the oxygen, though much weaker than that of the sulphur, since it cannot alone overcome the elasticity of the gas. The action of the sulphur is diminished by the sum of that attraction which it exerts upon the potash, and upon the water which serves as a solvent to the sulphuret; but it gains much more by the liquidity which it acquires, than it loses by this saturation. Strictly speaking, all those substances the solidity of which is overcome by a solvent, do act by virtue of a resulting force or affinity.

6. Circumstances contrary to the preceding produce an opposite effect; and when substances, by combining, become solid, or more disposed to crystallize, this circumstance must be added to the loss of force arising from the saturation. Potash, for example, and nitric acid, have both the property of dissolving in alcohol, and yet alcohol does not dissolve nitrate of potash; that is, the force of cohesion which belongs to that combination, and which, with water, produces its crystallization, has modified the elementary affinities into the resulting affinity. What confirms this explanation is, that salts which are not crystallizable in water, because they oppose only a feeble cohesion, have, in general, the property of dissolving in alcohol; but in such a manner, that they are capable of crystallizing in that fluid, because the weaker action of the alcohol cannot overcome, except to a certain point, the force of cohesion, of which they are not entirely destitute.

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The limited ſolubility of nitrate of potaſh in water ariſes from the ſolubility of the potaſh, as well as of the nitric acid, by water, being greater than by alcohol.

7. Bodies act in proportion to the quantity of them which exiſts within the ſphere of action. (Art. IV.) Hence we deduce, that an action much ſtronger than that of the component parts may reſult from a combination, when the components, or one of the two, paſs from the elaſtic to the liquid ſtate; for they then carry into the ſphere of activity a more conſiderable quantity, the action of which may conſiderably exceed the force loſt by the ſaturation. Thus potaſh cannot overcome the reſiſtance which proceeds from the elaſticity of the oxygen and azotic gaſes; but if theſe two be combined, in order to form nitric acid in the liquid ſtate, they act upon the potaſh in a quantity much greater than they could have applied when in the elaſtic ſtate; and the reſult of their action, though weakened by a commencement of ſaturation, is found to be much more conſiderable than if the azote and oxygen had continued in the elaſtic ſtate.

8. The affinity of a ſubſtance which enters into combination with a compound ſubſtance, concurs with the elementary affinities of the latter, to maintain its compoſition againſt the action of foreign ſubſtances, in proportion to the degree of ſaturation which it produces. Thus iron eaſily carries off oxygen from azote, or rather, it ſhares it, or takes a portion; but as ſoon as the nitric acid is combined with potaſh, iron can no longer ſeparate its oxygen at an ordinary temperature; but at a higher temperature the difference of dilatation ſufficiently deſtroys the reſulting affinity of the potaſh to cauſe the iron to combine with the oxygen. In the oxygenated muriatic acid, the ſur-oxygen, which is feebly retained by the muriatic acid, paſſes eaſily into other combinations; but though it is preſent in a much greater proportion in the oxygenated muriate of potaſh, it is carried off with much more difficulty by oxygenable ſubſtances. Phoſphate of lime is not decompoſed by charcoal even at a great degree of heat; but if it be in the ſtate of acidulous phoſphate, the portion of acid, which may be conſidered as in exceſs, is capable of being decompoſed by charcoal, becauſe not prevented by a ſufficiently large maſs of the baſe; and it is this part alone which affords phoſphorus, when, in order to obtain this ſubſtance, we uſe phoſphate of lime reduced to an acidulous phoſphate by the ſulphuric acid.

9. The contrary takes place when, inſtead of a ſaturating ſubſtance, which ſerves to ſtrengthen the reſulting affinity,

one is added that tends to form a combination into which one of the constituent parts must enter. For example, when sulphuric acid is added to a mixture of water and iron, this acid favours the decomposition of the water, because it tends to combine with the metal, and with a portion of oxygen; a tendency concurring, with that of the metal, against the affinity which forms the combination of oxygen with hydrogen.

10. From the preceding remarks we conclude, that the properties of the resulting affinity of compound substances may be reduced, 1. To the advantages of liquidity, and under this point of view it is necessary to apply to it the theory of solvents (Art. IX.): 2. To the disposition to solidity, which produces contrary effects, which must be explained by the force of cohesion (Art. V.): 3. Lastly, to the concentration of elastic substances. The observations presented in No. 7. and 8. prove that, in those compounds in which elastic substances are concentrated, there are established, by a change of constitution, affinities which may be considered as new; an additional force has accrued, to which we may apply the inverse of what has been stated relative to the effects of elasticity (Art. VI.) The distinctive character of the complex affinities treated of, (Art. XII.) compared with those which result from the composition of the substances of which I now speak, is, that in the first but very little change obtains in the constitution of the component parts; so that, when the force of cohesion or of elasticity does not intervene, we may consider them in the same manner as they have been considered in Art. XII. No. 1., whereas a new force is established in compounds in which elastic substances are condensed; a power which may be considered as analogous to that of the cohesion which obtains on the mixture of different substances that determine the combinations that are formed, or which require to be overcome by the forces opposed to it.

11. Caloric, by augmenting elasticity, destroys the affinity of substances, of which the constituent parts have an unequal dilatation, conformably to what has been stated in Art. VII.

12. Observation further shows us, that when the resulting affinity is not sufficient to prevent the decomposition, it sometimes renders it very slow and tedious. To this slowness of action, to these progressive changes of constitution, to the different degrees of saturation which take place, must be ascribed most of the phænomena observable in vegetation, fermentation, the animal œconomy, and, in general, among all bodies which contain condensed elastic substances.

ſubſtances *. This ſubject will require ſtill further explanation.

13. The reſulting affinity ought always to be conſidered as a ſingle force, while the ſubſtances from which it is derived remain in combination: but when a ſeparation takes place, it is neceſſary to conſider the elements of which it is compoſed; for the reſult will then be conformable to what has been explained in the diviſion of ſubſtances, in proportion to the oppoſite powers which act upon them.

14. It often happens that a ſubſtance acts partly by a reſulting affinity and partly by its elementary affinities. When a metal is diſſolved by the nitric acid, one part of the acid exerts a reſulting affinity, and another acts by its elementary affinities; ſo that the oxygen of the latter part is divided between the metal and the azote, and the oxide which is formed is diſſolved in the undecompoſed acid.

15. It is obvious, from what has juſt been explained relative to reſulting affinity, that a falſe idea may be adopted of the properties of a body, when we confine ourſelves, as is too often done, to the determination of its conſtituent parts, without paying attention to the other conditions of its conſtitution, if among thoſe conſtituent parts there chance to be ſome whoſe ſtate has undergone a conſiderable alteration. A quantity of oxygen gas does not poſſeſs the ſame chemical power when it is in the elaſtic ſtate, as when it exerts a reſulting force in its combination with azote, hydrogen, carbon, ſulphur, or a metal. For example, the oxygen does not exert the ſame action, and has not the ſame reſulting affinity, in the ſulphuric and the ſulphurous acid: though in the ſulphuric acid a ſmaller proportion of ſulphur is combined, yet it adheres much more ſtrongly than in the ſulphurous acid, and, being more condenſed, it exerts a much more powerful chemical action †. We ought not to confound the oxygen gas which is held in ſolution by water, with the oxygen which, by its combination with hydrogen, forms this liquid: the difference cauſed between them by the ſtate of condenſation, produces two ſubſtances very different in their chemical action. It is therefore neceſſary, either to conſider the whole conſtitution of a body, in order to explain its chemical properties, or to content ourſelves with

* I have often reſorted to this change of conſtitution in the chemical explanations which I have had occaſion to give, and particularly in the lectures of the National School, where I defined the reſulting affinity by the name of *collective affinity*, and diſtinguiſhed it from *elementary affinities*.

† I have obſerved the effects of condenſation in a memoir on the ſulphurous acid. (*Annales de Chimie* 1789.)

eſtabliſhing

establishing those properties by experiment; for we must pay attention to all the circumstances of chemical action, to explain the results of that action, or we must confine ourselves to their establishment or confirmation.

XV. Recapitulation.

1. We have frequently remarked that the action of a substance is diminished in proportion as it approaches a state of saturation; and this diminution of force was applied to explain several chemical phænomena. It was affirmed that a metal could only take a definite portion of oxygen from the nitric acid, because, when the oxygen in the acid is diminished, the remaining portion is too strongly combined with the azote. The property of carrying off only a portion of oxygen from certain metallic oxides was attributed to hydrogen; it was admitted that when a substance attracts humidity from the air, its dissolving force comes to an equilibrium; so that, according to the degrees of deficcation of the air, the substance may either carry off or give out water to it. It was shown that the resistance experienced in expelling the last portions of a substance from a combination, either by the action of an affinity or by that of heat, is much greater than at the commencement of the decomposition, and sometimes such, that its entire decomposition cannot be effected. Thus it was ascertained that oxygen could be but partially disengaged from the oxide of manganese by the action of heat. The combinations which are formed when forces are opposed, do not therefore depend upon the affinities alone, but upon the proportions of the substances which act. I have therefore only applied to *all* the phænomena of chemistry, what has been unavoidably admitted in *several* of them from observation. I have only deduced the immediate consequences.

2. These are, that substances act in proportion to their affinity, and to the quantity of them existing within the sphere of activity; that the latter may counterbalance the former affinity; and that the chemical action of each power is proportionate to the saturations it produces. I have defined by the word *mass*, or *chemical mass*, the quantities determined by a like degree of saturation, and consequently, relative to the capacity of saturation: when two substances are in competition in order to combine with a third, each of them obtains a degree of saturation proportionate to its mass. The subject of the combination also divides its action in proportion to the masses, and by varying the latter the results will also be varied.

3. I have

3. I have conſidered all the forces which, by their concurrence or oppoſition to the mutual affinity of the ſubſtances brought into action according to the preceding principle, may have an influence upon chemical combinations and phænomena. They may be reduced to the following heads: the action of ſolvents, or the affinity which they exert according to their proportion; the force of coheſion, which is the effect of the mutual affinity of the parts of a ſubſtance or combination; the elaſticity, whether natural or produced by heat, which ought to be conſidered as an affinity of caloric; the efflorescence, the cauſe of which may be attributed to an affinity which is not yet determined, and which acts only under very rare circumſtances; gravity likewiſe exerts its influence, particularly when it produces the compreſſion of elaſtic fluids; but it may always, without inconvenience, be confounded with the force of coheſion.

4. I have attempted to aſcertain whether it were poſſible to determine the relative affinity of two ſubſtances for a third; I have obſerved that for this purpoſe it would be neceſſary to diſcover in what proportions this third would be divided with a given quantity of each of the two firſt, or rather, would divide its action; I have pointed out the inſurmountable obſtacles that would be met with in the means that muſt neceſſarily be employed to prove this diviſion of action, and the changes of conſtitution which would attend it.

5. As all the tables of affinity have been conſtructed upon the ſuppoſition that ſubſtances poſſeſs different degrees of affinity, which produce the decompoſitions and combinations reſulting from their mixture, independently of the proportions and other conditions which contribute to the reſults, theſe tables can only give a falſe idea of the degrees of chemical action of the ſubſtances arranged in them.

6. Elective affinity is in itſelf an erroneous expreſſion, ſince it ſuppoſes the union of one entire ſubſtance with another, in preference to a third, while there is only a diviſion of action, ſubjected to other chemical conditions.

7. The action of two, three, or a greater number of ſubſtances is ſubject to the ſame laws; and the reſult depends on their affinity, on their proportion, or on the degree of their ſaturation, and the concurrence or oppoſition of the forces they exert.

In all caſes of perfect liquidity, mutual ſaturation takes place, and the reſult is a ſingle combination, in which all the forces are counterbalanced, while there is neither precipitation nor diſengagement of elaſtic matter; but as the action is divided when there is an oppoſition of forces and a differ-

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ence of ſaturation, ſome ſubſtances are retained in the new combination leſs ſtrongly than before the mixture; they may conſequently yield to the powers of coheſion, elaſticity, or other affinities which they might otherwiſe have reſiſted.

8. The force of coheſion, hitherto conſidered merely as an obſtacle to ſolution, not only limits the quantities of ſubſtances which may be brought into action in a liquid, and conſequently modifies the conditions of the ſaturation which follows, but is the power which cauſes the precipitations and cryſtallizations that take place, and determines the proportions of ſuch combinations as quit the liquid: it is this force which ſometimes even produces the ſeparation of one, without its forming any combination with another ſubſtance, as we have remarked in ſome metallic precipitations. I diſtinguiſh inſolubility from the force of coheſion, becauſe the one is relative only to the action of the ſolvent, and the other is the effect of the mutual affinity of the parts of a ſubſtance or combination, conſidered abſolutely.

Elaſticity acts by producing effects oppoſite to thoſe of coheſion, which conſiſt in either withdrawing ſome ſubſtances from the action of others in a liquid, or in diminiſhing the proportion which exiſts within the ſphere of activity; but when all the ſubſtances are in the elaſtic ſtate, their action is ſubjected to the ſame conditions.

If tables were formed which would repreſent the diſpoſition to inſolubility or volatility in the different combinations, they would ſerve to explain a great number of combinations which take their origin from the mixture of different ſubſtances, and from the influence of heat.

9. Caloric acts upon bodies like the other ſolvents, when it is not in a ſtate of *radiant caloric*, becauſe in this caſe it is not in combination. It ſhould exceed the greateſt part of the force of coheſion, in order to render a body liquid; other affinities alſo may concur with it to produce this effect, in the ſame manner as itſelf concurs with the action of other ſolvents. It is not diſtributed among bodies in proportion to their weight, or to their bulk, when it produces the degrees of temperature indicated by the thermometer, in the ſame manner as an acid does not take up an equal quantity of the different alkalis, to attain the ſame degree of ſaturation; and were tables of ſpecific caloric conſtructed, they would be ſimilar to thoſe of ſpecific acidity or alkalinity. The latter, however, would repreſent the whole ſaturation to a certain aſſumed point, becauſe pure acids and alkalis might be employed; but the ſpecific calorics could only be determined

mined from an unknown point of ſaturation to another point, the bodies ſubmitted to experiment being already combined with a quantity of caloric. The reſults, which may be obtained between two points of the ſcale of the thermometer, have no known connection with the total quantities. To attempt to form a concluſion of one from the other, would be the ſame as to pretend to determine the comparative ſolubility of the muriate of ſoda, and the nitrate of potaſh in water, by experiments made only at or towards the point of ebullition or of congelation. In the former caſe we ſhould ſay that three parts of water would be required for the ſolution of one part of muriate of ſoda, and only half a part would be neceſſary to diſſolve one part of the nitrate of potaſh; in the latter, that much leſs water would be required to diſſolve the muriate of ſoda than to diſſolve the nitrate of potaſh *.

The force of coheſion in a body on its taking the ſolid ſtate obliges a part of the caloric to ſeparate; in the ſame manner as when a ſalt cryſtallizes, it abandons part of the ſolvent, or even a part of the acid, or of the alkali, with which it might be combined.

10. It may be ſaid that the affinities may really be repreſented by the tables of capacity; ſince they may afford the meaſure of the action of one ſubſtance upon another, when a common term of ſaturation is found, ſuch as neutralization for the acids and the alkalis, and thermometric temperature for caloric; but nothing could poſſibly be concluded for chemical action at another term of ſaturation, and more particularly for another conſtitution, and for all the circumſtances in which the forces of elaſticity and coheſion might not be introduced.

11. Having conſidered all the affinities which may jointly produce chemical action, I next examined how, in the compounds, they may reſult from their conſtituent parts, in order to acquire a conception how the varied powers, which produce all the chemical phænomena, can be derived from one ſingle property of ſimple bodies. The obſervations preſented on this ſubject have ſhown, that what principally diſtinguiſhes compound ſubſtances, whoſe action is conſidered as ſimple, is, the condenſation of the conſtituent parts, on which a new affinity depends; an affinity very different from that which the ſame parts poſſeſs in the elaſtic ſtate: the elementary

* This conſideration alone, that ſpecific caloric has no known relation to the quantity of caloric combined in a body; ſhows that the experiments by which Rumford has lately pretended to prove that caloric is not a conſtituent part of bodies, cannot lead to ſuch a concluſion.

affinities

affinities are modified by the ſtate of ſaturation, by the force of coheſion, or by the variations of elaſticity: the reſulting affinity may undergo, by combination, a new degree of ſaturation which tends to ſupport the compoſition, or may be weakened by other tendencies to combination with one of the conſtituent ſubſtances.

12. The conſiderations which I have preſented reſpecting the modifications of chemical action, do not, however, prevent us from uſing the term *affinity* to denote the whole chemical power of a body exerted in a given ſituation, either by its preſent conſtitution, its proportion, or even by the concurrence of other affinities; only we muſt avoid conſidering this power as a conſtant force; for it would be erroneous to infer from its preſent effects, in any inſtance, what they would be under other conditions.

[To be continued.]

XXII. *A Treatiſe on the Cultivation of the Vine, and the Method of making Wines.*

[Continued from p. 19.]

V. The Method of taking the Wine from the Vats, and the proper Period for that Purpoſe.

AT all times agriculturiſts have conſidered it as a matter of great importance, to be able, by unerring ſigns, to diſcover the moſt favourable period for taking the wine from the vats; but here, as in other things, they have fallen into the very great inconvenience of general methods. This period ought to vary according to the climate, the ſeaſon, and the nature of the wine propoſed to be obtained, and of other circumſtances, which muſt always be kept in view.

It will be proper for us, therefore, to lay down principles rather than to preſcribe methods; for, in our opinion, this is the only way to make ourſelves maſters of the operations, and to bring together the whole of thoſe phænomena, the knowledge and compariſon of which become neceſſary before any deciſion, founded upon certainty, can be given.

Some agriculturiſts have ventured to determine a fixed period for fermentation; as if it ought not to vary according to the temperature of the air, the nature of the grapes, the quality of the wine, &c. Others conſider as a ſign that the wine is fit to be removed from the vats, the ſinking down of the vintage, being certainly ignorant that almoſt the whole of

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the wines of the North would lose their most valuable qualities, if their removal of the vats were delayed till that time.

There are some countries where it is judged that the fermentation is completed, when the wine, after being put into a glass, exhibits no foam at the top, and no air-bubbles at the sides of the glass. In other places it is thought sufficient to shake the wine in a bottle, or to pour it from one glass into another several times, to ascertain whether there exists any foam. But besides that all new wines give more or less foam, there are many in which that mark of effervescence ought to be preserved, in order that they may not lose one of their principal properties.

In some countries, a stick is immersed in the vat, and speedily drawn out; the wine is then suffered to drop from it into a glass, to see whether a circle of foam is formed in it, which is called *faire la roue*. Some thrust their hand into the refuse, and, applying it to their nose, judge, by the smell, of the state of the vat: if the smell is mild, they allow the wine to ferment some time longer; if it is strong, it is removed from the vats.

Some agriculturists, also, consult only the colour in order to regulate the period of removing the wine from vats. They suffer it to ferment till the colour becomes sufficiently dark: but the coloration depends on the nature of the grapes; and must in the same climate, and produced from the same soil, does not always show the same disposition to acquire colour; which renders this sign exceedingly variable and very insufficient.

It thence follows, that all these signs, taken separately, cannot exhibit invariable results; and that, if we wish to rest on fixed bases, recurrence must be had to principles.

The object of fermentation is to decompose the saccharine principle: the more abundant, therefore, this principle is, the fermentation must be brisker, or continued for a longer time.

One of the inseparable effects of fermentation is, the production of heat and carbonic acid gas. The first of these results tends to volatilize and to disperse the flavour and smell, which forms one of the principal characters of certain wines. The second carries outwards, and causes to be lost in the air a fluid, which if retained in the beverage would render it more agreeable and pungent. From these principles it follows, that weak wines, but of an agreeable flavour, require little fermentation; and that colourless wines, the principal property of which is to be brisk, ought to remain scarcely at all in the vats.

The most immediate product of fermentation is the formation

tion of alcohol, which results immediately from the decomposition of the sugar. When the grapes, therefore, are very saccharine, such as those of the south, the fermentation must be brisk, and long continued; because these wines, being destined for distillation, ought to produce immediately all the alcohol that can result from the decomposition of the whole of the saccharine principle. If the fermentation be slow and weak, the wines remain luscious, and do not become warm and agreeable till they have long worked in the vats.

In general, grapes abundant in the saccharine principle must ferment a long time. In the Bordelois, the fermentation is suffered to work itself to an end: the wine is never removed from the vats till the heat has subsided.

According to these principles and others, deduced from the theory before established, we may draw the following consequences:

1st, The must ought to remain in the vats the less time according as it is less saccharine. Light wines, called in Burgundy *vins de primeur*, cannot bear the vat above from six to twelve hours.

2d, The must ought to remain the less time in the vats, according as it is proposed to retain the acid gas, and to form brisk wines: in that case, it is thought sufficient to tread the grapes, and to put the juice into the casks after it has been left in the vat twenty-four hours, and sometimes without having been in the vat at all. In this case, the fermentation, on the one hand, is less tumultuous; and, on the other, the gas can with less ease be volatilized; which contributes to retain that highly volatile substance, and to make it one of the principles of the liquor.

3d, Must ought to be left in the vats less time, according as it is proposed to obtain wine less coloured. This condition is of great importance in regard to brisk wines, one of the most valuable qualities of which is their want of colour.

4th, Must ought to remain in the vats less time, according as the temperature is warmer, and the mass more voluminous, &c.: in that case, the briskness of the fermentation makes up for its shortness of duration.

5th, The must ought to remain in the vats less time, according as it is proposed to obtain wine of a more agreeable flavour.

6th, The fermentation, on the other hand, will be longer, according as the saccharine principle is more abundant, and the must thicker.

7th, It will be longer if the wines are destined for distilla-

tion; in which caſe, every thing ought to be ſacrificed to the production of alcohol.

8th, The fermentation will be longer, according as the temperature has been colder when the grapes were collected.

9th, The fermentation will be longer, according as the wine is required to be more coloured.

From theſe principles it may be conceived why in one country the fermentation in the vat terminates in twenty-four hours, while in others it continues for twelve or fifteen days; why one method cannot be generally applied; and why particular proceſſes may be attended with errors, &c.

Gentil admits as an invariable ſign of the neceſſity of removing the wine from the vat, the diſappearance in regard to taſte of the ſweet and ſaccharine principle. This diſappearance, as he obſerves, is only apparent, but the ſavour of the little that remains is concealed; the alcohol, the ſavour of which predominates, terminates its decompoſition in the caſks. It is alſo evident that this ſign, which is not at all applicable to white wine, cannot be employed for wines deſtined to remain luſcious.

The ſigns deduced from the ſinking down of the head or refuſe, and the coloration of wines, are attended with the like inconveniences, and we muſt return from them to the principles above eſtabliſhed. This is the only method of avoiding error.

A provident agriculturiſt will always prepare his caſks, on the approach of the vintage, in ſuch a manner that they may be ready to receive the wine as it comes from the vat. The preparation given to them is as follows:

If the caſks are new, the wood of which they are compoſed retains an aſtringency and bitterneſs, which may be tranſmitted to the wine; and theſe faults may be corrected by pouring warm water and ſalt water into them ſeveral times in ſucceſſion. Theſe liquors muſt be well ſhaken, and ſuffered to remain in them till they penetrate the texture of the wood, and extract the pernicious principle. If the caſks are old, and have been frequently employed, one end of them is opened: the ſtratum of tartar, with which the inſide is covered, is ſcraped off, and they are waſhed with warm water or with wine.

In general, the moſt uſual methods of preparing the caſks are confined to the following:

1ſt, Waſh the caſk with cold water, then pour into it a quart of ſalt water in a ſtate of ebullition; ſtop the bung-hole, and ſhake it in every direction: empty it, let the water drain well off; then take two quarts of fermenting muſt, and,

having boiled and ſkimmed it, pour it boiling hot into the caſk; cloſe it and again ſhake it, after which ſuffer it to drain off.

2d, Warm wine may be employed inſtead of the above preparations.

3d, An infuſion of the flowers of the peach-tree, &c. may alſo be uſed.

When the caſks have acquired any bad quality, ſuch as muſtineſs, &c. they muſt be burnt: it is poſſible to conceal theſe defects, but there is reaſon to fear they might reappear.

The antient Romans put gypſum, myrrh, and various aromatic ſubſtances into the caſks into which their wines were removed from the vat. This is what they called *conditura vinorum*. The Greeks ſometimes added a little bruiſed myrrh and argil. Theſe ſubſtances not only perfumed the wine, but ſerved alſo to clarify it.

When the caſks are properly prepared, they are depoſited on caſk-ſtands, and thus raiſed ſome inches from the ground, both to prevent the action of putrid humidity, and for the more convenient drawing off the wine which they contain. They muſt be arranged in parallel rows in the cellar, with ſufficient room between for a perſon to examine whether any of them leaks.

In the caſks thus prepared the wine is depoſited: when it is thought to have remained a ſufficient time in the vat for this purpoſe, the tap of the vat, which is raiſed ſome inches above the ground, is opened, and the wine is ſuffered to run into a reſervoir, generally conſtructed below, or into a veſſel placed on purpoſe to receive it: the wine is immediately drawn from the reſervoir and carried to the caſks, into which it is introduced by means of a funnel.

The liquor which floats over the depoſit of the vat is called in Burgundy *ſurmoût*. This *ſurmoût* is carefully drawn off, and put into caſks capable of containing 30 gallons, or into half caſks of 15. This *ſurmoût* forms a lighter kind of wine, more delicate and leſs coloured.

When all the wine which the vat can furniſh has been drawn off, nothing remains but the head, which has ſunk down almoſt to the depoſit. This refuſe is ſtill impregnated with wine, and retains ſuch a quantity, that it may be extracted by means of the preſs. But as the head, which has been in contact with the atmoſpheric air, for the moſt part contracts a little acidity, eſpecially when the vintage has remained a long time in the vat, it muſt be carefully ſeparated, in order to be preſſed by itſelf; by which means it will produce very good vinegar.

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When the depoſit in the vat has been preſſed, the vine that flows from it is put into the caſks with the reſt; after which the preſs is eaſed, and the refuſe is cut quite round, to the thickneſs of three or four inches, with a ſharp ſhovel; that which has been cut off is thrown into the middle, and again ſubjected to the preſs: the operation of cutting is a ſecond time repeated, and the cut matter is preſſed as before.

The wine ariſing from the firſt *cutting* is the ſtrongeſt; that ariſing from the third is harder, harſher, greener, and more coloured.

Sometimes a firſt cutting is thought ſufficient, eſpecially when the refuſe is deſtined for the acetous fermentation. The product of theſe different cuttings is often mixed together in ſeparate caſks, in order to obtain wine coloured and pretty durable; and in ſome places it is mixed with common wine when it is required to give to the latter colour, ſtrength, and a ſlight aſtringency. In Champagne, the wine of the firſt preſſing is mixed with that ariſing from ſucceeding cuttings.

The wine of the preſs is the leſs coloured according as it is preſſed more weakly and more ſpeedily. Theſe wines in Champagne are called *gray wines*. The wine ariſing from the firſt and ſecond cutting is called *œil de perdrix*; and that ariſing from the third and fourth, *vin de taille*: the laſt is the moſt coloured, but it is ſtill agreeable.

The refuſe, when ſtrongly preſſed, acquires ſometimes the hardneſs of ſtone. It is applied to various uſes in commerce.

1ſt, In ſome countries it is diſtilled in order to make a ſpirit, which is called *eau-de-vie de marc*. In Champagne it is known under the name of *eau-de d'Aixne*; but it has a bad taſte. This diſtillation is advantageous, eſpecially in countries where the wine is highly generous, and where the preſſes do not preſs very cloſely.

2d, In the neighbourhood of Montpellier, the refuſe is put into caſks, where it is carefully trod upon; and it is then preſerved for making verdigris *.

3d, In other places it is rendered acid by carefully airing it, and the vinegar is then extracted by ſtrong preſſure. The expreſſion may even be facilitated by moiſtening it with water.

4th, In ſeveral cantons the cattle are fed with the refuſe: as it comes from the preſs, it is broken with the hands in order to divide the lumps; it is then thrown into caſks, where it is moiſtened with water, and it is covered with earth mixed with ſtraw: this covering is about 7 or 8 inches in thickneſs. When bad weather prevents the cattle from going out into the fields, about 6 or 7 pounds of this refuſe

* See Philoſophical Magazine, Vol. IV.

is ſoaked in warm water with bran, ſtraw, turnips, potatoes, and oak or vine-leaves, which have been preſerved on purpoſe in water: a little ſalt may be added to this mixture, which is given to the cattle in a tub evening and morning. Horſes and cows are fond of this food; but it muſt be given to the latter in moderation, becauſe it would cauſe their milk to turn ſour. The refuſe of white grapes is preferred on account of its not having been fermented.

5th, The ſtones contained in the grapes ſerve for feeding poultry: oil, alſo, may be extracted from them.

6th, The refuſe may be burnt to obtain alkali: 4000 pounds of refuſe yield 500 pounds of aſhes, which give 10 pounds of dry alkali.

VI. Of the Method of managing the Wine in the Caſks.

The wine depoſited in the caſks has not reached its laſt degree of preparation. It is turbid, and ſtill ferments; but, as the movement of it is leſs tumultuous, this ſtate of it has been called the *inſenſible fermentation*.

Soon after the wine has been put into the caſk, a ſlight hiſſing is heard, which ariſes from the continued diſengagement of the carbonic acid gas that eſcapes from every point of the liquor; foam, which paſſes over through the bung-hole, is formed at the top, and care is taken to keep the caſk always full, that the foam may eſcape, and that the wine may diſgorge itſelf. For a ſhort time it will be ſufficient to faſten a piece of paper on the bung, or to lay a tile over it.

In proportion as the fermentation decreaſes the maſs of the liquid ſinks down; and this depreſſion is carefully watched, in order to pour in more wine, that the caſks may be always kept full. There are ſome countries where this operation is performed every day for the firſt month, every four days during the ſecond, and every eight till it is drawn off. This is the method practiſed in regard to the delicious wines of the Hermitage.

In Champagne, the *gray wines* are ſuffered to ferment in the caſks ten or twelve days; and when they ceaſe working up, the caſks are cloſed by means of the bung, leaving a ſmall vent-hole at one ſide of it. This vent-hole is cloſed eight or ten days after with a wooden peg, which may be taken out at pleaſure. When the caſks have been cloſed, freſh wine muſt be poured in through the vent-hole, every week for twenty-five days; then every two months as long as the wine remains in the cellar. When the wines have not ſufficient body, and are too green, which is the caſe when the ſeaſon has been damp and cold; or if they are too luſcious, which is the

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caſe when the ſeaſon has been too dry and warm, the caſks are rolled five or ſix times twenty-five days after the wine has been made, to mix well the lees; and this operation is repeated every eight days during a month: by theſe means the wine is improved.

The fermentation of the wines of Champagne deſtined to be briſk is continued very long: it is believed that wine can conſtantly be briſk, provided it be put into bottles between the time of the vintage till the month of May; and that, the nearer to the time of the vintage, the better it foams. We are aſſured alſo that it always foams if put into bottles between the 10th and 14th of March. Wine never begins to foam till ſix weeks after it has been put into bottles. Mountain wine foams better than Champagne: when wine is put into flaſks between June and July it foams little, and not at all if bottled in October or November, after the vintage.

In Burgundy, when the fermentation in the caſk has ſlackened, the caſks are cloſed, and a ſmall hole is made in them near the bung, which is cloſed with a peg. This peg is drawn out from time to time to ſuffer the remainder of the gas to eſcape.

In the environs of Bourdeaux it is cuſtomary to begin pouring in new wine eight or ten days after the wine has been put into the caſks. A month after, the bung is put in, and new wine is poured in every eight days: at firſt, the bung is put in very gently, and it is gradually driven in cloſer without incurring any danger.

The white wines are drawn off about the middle of December, and they are then ſulphured. The white require more care than the red, becauſe they contain more dregs, and are more diſpoſed to become oily.

Red wines are not drawn off till the end of March or beginning of April. The latter eaſier turn ſour than the white, which renders it neceſſary to keep them in cooler cellars during the hot weather.

Some people, after the ſecond drawing off, turn the barrels with the bung on one ſide, and thus keep the wine hermetically ſealed, without having need to pour in new wine, as there is no loſs. The wine then is not drawn off but every year at the ſame period, until it is found convenient to drink it. As the proceſſes every where followed are nearly the ſame, we ſhall not multiply details, which would be only repetitions.

When the fermentation has ceaſed, and the maſs enjoys perfect repoſe, the wine is completely made. But it acquires new qualities by clarification; and by this operation is preſerved from the danger of turning ſour.

This clarification is effected ſpontaneouſly by time and repoſe; and there is gradually formed a depoſit at the bottom of the caſk and on the ſides, which frees the wine from every thing not in abſolute ſolution in it, or which is in it in exceſs. This depoſit, called the lees, *fæces*, is a confuſed mixture of tartar principles, analogous to fibrous matter and colouring matter.

But theſe matters, though depoſited in the caſk, and precipitated from the wine, are ſuſceptible of being ſtill mixed with it by agitation, change of temperature, &c.; and in that caſe, beſides injuring the quality of the wine, which they render turbid, they may communicate to it a new fermentation, which makes it degenerate into vinegar.

To obviate this inconvenience, the wine is drawn off into other veſſels at different periods; all the lees which have been precipitated are carefully ſeparated; and every thing exiſting in it in a ſtate of incomplete ſolution is diſengaged from it by ſimple proceſſes, which we ſhall hereafter detail. By means of theſe operations it is cleanſed and purified, and deprived of all thoſe matters which might determine acetification.

Every thing that relates to the art of preſerving wines may be reduced to *ſulphuring* and *clarification*.

Sulphuring of Wine.

1ſt, To ſulphur wine is to impregnate it with a ſulphurous vapour obtained by the combuſtion of ſulphured matches.

The method of compoſing theſe matches varies conſiderably in different places; ſome mix with the ſulphur aromatic ſubſtances, ſuch as powder of cloves, cinnamon, ginger, Florentine iris, flowers of thyme, lavender, marjoram, &c. and melt the mixture in an earthen veſſel over a moderate fire. In this melted mixture, rags of cotton cloth are dipped in order to be burnt in the caſks. Others employ ſulphur alone, which they melt over the fire, and dip rags in it in the ſame manner.

In the method of ſulphuring caſks there is alſo conſiderable variety. Sometimes the match is ſuſpended at the end of an iron wire; it is then lighted, and put into the caſk intended to be filled with wine; the caſk is then ſtopped, and the match is left to burn: the internal air becomes dilated, and is expelled, with a hiſſing noiſe, by the ſulphurous gas: two, three, or more matches are burnt in this manner, according as may be thought neceſſary. When the combuſtion is terminated, the ſides of the caſk are ſcarcely acid; the wine is then poured into it. In other countries, two or three pailfuls of wine are poured into a good caſk; a ſulphured

phured match is then burnt in it; and when the combuſtion is finiſhed, the caſk is ſtopped, and ſhaken in every direction. After being left at reſt for an hour or two, it is unſtopped, more wine is added; it is then again ſulphured, and the operation is repeated till the caſk be full. This is the proceſs uſually followed at Bourdeaux.

At Marſeillan, near the commune of Cette, in Languedoc, a kind of wine is made of white grapes called *mute wine*, which is employed to ſulphur others. The vintage is trod and preſſed without giving it time to ferment; it is then put into caſks filled one-fourth; ſeveral matches are burnt over it; and the caſks are ſtrongly ſhaken, until no more gas eſcapes through the bung-hole when opened. A new quantity of wine is then added, matches are again burnt over it, and the caſks are ſhaken with the ſame precautions. This operation is repeated till the caſk is full. This wine never ferments, and for that reaſon is called mute wine (*vin muet*). It has a ſweetiſh ſavour, a ſtrong ſulphurous odour, and is employed for mixing with other wine. Two or three bottles of it are put into a caſk. This mixture is equivalent to ſulphuring.

Sulphuring firſt renders wine turbid, and gives it a bad colour; but the colour is reſtored in the courſe of time, and the wine becomes clear. This operation whitens the wine a little. Sulphuring is attended with the very valuable advantage of preventing it becoming acetous. Though it be difficult to explain this effect, it appears to me that it cannot be conceived but by conſidering it under two points of view:

1ſt, By the help of the ſulphurous gas the atmoſpheric air is diſplaced, which otherwiſe would become mixed with the wine, and determine acid fermentation.

2d, Some atoms of a violent acid, which oppoſes and overcomes the development of a weaker acid, are produced.

The antients compoſed a kind of maſtic with pitch, a fiftieth part of wax, and a little ſalt and incenſe, which they employed for burning in their caſks. This operation was denoted by the words *picare dolia*, and the wines thus prepared were known under the names of *vina picata*. They are mentioned by Plutarch and Hippocrates.

It was, perhaps, in conſequence of this cuſtom that the fir was conſecrated by the antients to Bacchus: at preſent, an agreeable perfume is communicated to weakened red wine by making it remain over a ſtratum of the ſhavings of fir. Baccius ſays that the caſks ought to be pitched (*picare dolia*) during the dog days.

[To be continued.]

XXIII. *Researches on Alumine. Read Dec.* 18, 1800, *in the Society of Physics and Natural History at Geneva. By* THEODORE DE SAUSSURE.

[Concluded from p. 36.]

On the different Degrees of the Desiccation of pure Alumine in its different States.

ALUMINE, precipitated by ammonia and by the carbonate of ammonia, exhibits itself under two very different aspects, according to the quantity of water in which the aluminous salt is dissolved, though the weight of the precipitates be the same when they are dried in a temperature of from 65 to 75 of Fahrenheit.

If the quantity of water does not exceed what is necessary for the solution of the aluminous salt, a white earth is obtained, light, friable, exceedingly spongy, and which adheres to the tongue. I shall distinguish it by the name of *spongy alumine*.

But if the aluminous salt is dissolved in a very large quantity of water, there is obtained, after the precipitate has been dried at the above temperature, a transparent mass *, yellow and brittle, which when in fragments is somewhat voluminous, breaks or splits in the hand as sulphur does in the like case; it has a smooth and conchoid-formed fracture, without any earthy aspect, does not adhere in any manner to the tongue, and neither swells up nor resolves itself into water: it presents a volume of only a tenth or a twelfth of what the same weight of the spongy alumine does, and resembles gum arabic or dried jelly. I shall give it the name of *gelatinous alumine*.

* Opacity is not, then, essential to alumine, but when, in this or in the gelatinous state, it has been exposed to a violent heat. I do not know whether it was in this state that it was considered by Fourcroy, when he says, in his *Système des Connoissances Chimiques*, that alumine appears opaque in its ultimate molecules; that it reflects the light entirely; and that it communicates that property to stones, into which it enters in a large quantity. But there are many exceptions which destroy this *general rule*. I shall remark, that alumine, considered either in its spongy state or in that of its complete desiccation, appears opaque only by the division of its parts. With a good microscope, which magnified 200 times, I observed gelatinous alumine in fine powder, after being exposed to a heat expressed by 170 degrees of Wedgewood's pyrometer. It was transparent in its smallest molecules, though the powder of alumine had experienced neither agglutination nor fusion. The sapphire, the topaze, the cymophane, and the ruby, contain more alumine than is found in any opaque stone or rock at the surface of the earth; and yet these gems are transparent! By being too eager to establish *general rules*, we fall into confusion.

If

If ammonia be employed to precipitate gelatinous alumine, it is not neceſſary to dilute the ſolution with ſo large a quantity of water as when the carbonate is uſed, becauſe the diſengagement of the carbonic acid contributes to give to the precipitate a ſpongy appearance. But liquid ammonia highly concentrated can itſelf furniſh a *ſpongy alumine*, when the ſolution of alumine is much concentrated, becauſe the elements of the precipitate have not ſufficient room to float freely in the liquor, and to diſpoſe themſelves in ſuch a manner that the light may not be refracted in paſſing from one molecula to another.

Spongy alumine and gelatinous alumine, dried at the temperature of the atmoſphere, contain the ſame quantities of water, as I ſhall ſoon prove. But the former, on account of its minute diviſion, abandons, at the firſt degrees of incandeſcence, all the water it can contain; while the latter, more compact, retains a part at the higheſt degree of heat that our furnaces can produce.

A hundred parts of ſpongy alumine loſe in weight, at a red heat, lower than that which makes ſilver enter into fuſion, fifty-eight parts; and it does not loſe a greater quantity at 130 degrees of Wedgewood's pyrometer, a heat capable of fuſing iron.

A hundred parts of gelatinous alumine, at the firſt degrees of incandeſcence, loſe forty-three parts of their weight; and only forty-eight parts and a quarter at 130 degrees of Wedgewood's pyrometer.

To demonſtrate that ſpongy alumine and gelatinous alumine, when dried at a temperature between 10 and 20 degrees of Reaumur, contain the ſame quantities of water, I diſſolved in nitric acid 100 parts of gelatinous alumine, dried at a temperature between 15 and 20 degrees of Wedgewood's pyrometer, aſſiſting the ſolution by mixing it with potaſh at a fuſing heat. The purified alumine was precipitated with the precautions already preſcribed for obtaining this earth under the *ſpongy* form. It was then dried at a temperature between the 15th and 20th of Wedgewood's pyrometer, and it weighed then only twenty-five parts. A hundred parts of gelatinous alumine, dried at the firſt degrees of incandeſcence, retain, then, about fifteen parts of water; which agrees with the reſults above announced.

I have entered into theſe details, which are doubtleſs minute, only becauſe great errors may have been committed in chemical analyſes by eſtimating, as hitherto appears to have been the caſe, the quantity of alumine by the weight of this dried earth obtained at that red heat which generally indicates the firſt degrees of incandeſcence. This method is exact only

when the alumine is in the ſpongy ſtate: it is liable to an error of fifteen hundredths when it is in a gelatinous ſtate; and in that caſe, nothing can be done but to dry it at a temperature between the 65th and 90th degree of Reaumur, and to diminiſh its weight in the ratio of 58 per cent.; or, what is ſtill better, to effect its ſolution, and precipitate it in the ſpongy ſtate. If this earth, then, dried at the temperature of the atmoſphere, does not loſe at a red heat about 58 hundredths of its weight, it may be preſumed that it is pure.

Conſiderations on the Application of gelatinous Alumine to Pyrometry.

Gelatinous alumine experiences, at a heat ſucceſſively augmented, loſſes of weight which, at equal intervals of heat, follow a decreaſing progreſſion; to know the law of which would be very important, becauſe they might ſerve for eſtimating, in a preciſe manner, the different degrees of heat. I aſcertained, by repeated experiments, made with care, that the quantity of water it loſes is invariable; that is to ſay, that when the earth has attained its *maximum* in regard to loſs of weight at a certain degree of heat, the continuance of the heat at that degree has no influence in producing any further deſiccation. Though the experiments I made in other reſpects, to obtain ſome information on the poſſibility of applying gelatinous alumine * to pyrometry, were far from affording me ſatisfaction, I ſhall deſcribe them with all their imperfections. They will be of ſome uſe to thoſe who may have perſeverance enough to purſue theſe reſearches.—A hundred parts of gelatinous alumine in powder, and dried at the temperature of from 65 to 88 degrees of Fahrenheit, loſe at the temperature of

Degrees of Fahrenheit.	Wedgewood's Pyrometer.	Parts of Water volatilized.
144·5 -	- - -	- 12·2
257·0 -	- - -	- 19
369·5 -	- - -	- 23·7
482·0 -	- - -	- 27·2
	13 -	- 42·3
	29 -	- 45
	85 -	- 46
	106 -	- 47·5
	133 -	- 48·25
	170 †	- 48·25

These

* As ſpongy alumine abandons all the water it contains at a ſlight incandeſcence, it can be employed only for lower degrees.

† The ſhrinking of pyrometric cylinders, and, in general, of argils, by heat, is aſcribed to the expulſion of water. This opinion is true beyond a doubt

These experiments were each made on 50 grains only, and with a balance which I cannot warrant to have been free from an error less than a quarter of a grain. They are far, therefore, from that degree of precision which is necessary to determine the law of the progression in question.

These results, in regard to the uniformity of their progress, do not agree with Wedgewood's pyrometer; but I must observe, that this instrument is too uncertain to be employed for determining the law of desiccations.

C. Necker, to whom I am indebted for the use of that which I employed, exposed to the same heat, and for the same time, eight pyrometric cylinders in a crucible of platina. He saw with me that they indicated 127—126—111—107—98—96—93—90 degrees of their scale. Some of them were vitrified; others remained in the state of porcelain, or changed their form more or less; others experienced none of these accidents. These results arise from the inequality of the mixture of which the paste of the cylinders is formed. It can hardly be supposed, that two artists, though furnished with the same formula, can be able to make similar cylinders, because of the different degrees of the pulverization of the silex, which will never be the same, and will always have a great influence on the result. C. Gazeran obtained this equality, which he even surpassed, only by laborious and multiplied trials, though founded on an analysis of Wedgewood's cylinders*.

It is here seen, that if the property which alumine possesses at low temperatures, of losing only a determinate quantity of water at a constant degree of heat, continues unimpaired at a more elevated heat, it is possible that, by employing for

a doubt in regard to low temperatures; but I think it in a great part erroneous, in regard to the shrinking of pyrometric clay at a temperature above the 29th degree of that instrument. The experiment on which I found this idea is as follows:—I weighed, with a balance sensible to the eighth of a grain, the pyrometric piece of the last experiment. Before put into the fire, it weighed 32½ grains. I took it out at the 29th degree, and it had then lost 2½ grains. After that term to the 170th of the same scale it did not sensibly change its weight, and yet during that interval it had lost more than the fourth of its volume. This shrinking, therefore, does not arise merely from the expulsion of the water, but rather, and almost exclusively, from the new combinations or modifications which the earthy elements of the argil experience at a high temperature.

At the 170th degree, the platina crucible containing the alumine gave, at its exterior surface, proofs of very great emollition, and almost of fusion. This surface, in some of its parts, exhibited a confused crystallization similar to that exhibited by Carrara marble when polished. The platina covering, though very thick, sunk down, and was slightly fused in some places.

* Philosophical Magazine, Vol. IX. p. 155.

each

each experiment about 200 grains of alumine, and a balance sensible to the twentieth of a grain, as great exactness will be attained as that given by Wedgewood's pyrometer in its state of perfection; but it is seen, also, that these observations cannot be extended beyond the 130th degree of that pyrometer, because at a higher the losses in weight of the alumine are little or not at all sensible in small quantities.

The method I propose would be particularly useful when it were wished to determine the degrees comprehended between the 257th degree of Fahrenheit and the weakest incandescence; degrees not comprehended in Wedgewood's scale, and which cannot be, on account of the dilatation experienced by argil before it attains to a red heat. I shall here mention some precautions which ought to be employed in order to make these observations with exactness.

1st, The desiccation of gelatinous alumine at the temperature of the atmosphere is uncertain; it may not be equal in all the parts of the earth; it is proper then to pulverize it, and to set out from a fixed degree of desiccation. For that purpose, a small part must be exposed to a heat of 257° F. by putting it together with that thermometer into a glass tube, closed at one of its extremities, and immersed in a sand-bath heated by an Argand's lamp, the heat of which is graduated at pleasure. The loss of weight sustained by the alumine, dried at the temperature of 257°, is to be deducted in all operations performed with earth dried at the temperature of the atmosphere. The dried earth may be preserved in a bottle with a ground stopper.

I have indicated the 257th degree of Fahrenheit as the lowest term, because, at degrees lower than that of boiling water, the loss of weight in the alumine dried at the temperature of the atmosphere takes place with great slowness.

To desiccate two drams and a half I employed

Nine hours in a heat of		144° F.
Two hours	- -	257
Half an hour	-	482

The termination of this process may be readily perceived when the tube which contains the alumine ceases to be obscured by the vapours that escape.

2d, In operations at degrees lower than incandescence, it is proper to weigh the earth at the moment when it comes from the fire, because at the end of an hour or two it takes from the atmosphere a quantity of water, which may produce an error of one or two hundredths.

XXIV. *Some Account of the Life of the late Dr.* Joseph Black.

THIS eminent chemiſt was born at Bourdeaux, in France, in the year 1728. His parents were both natives of Great Britain, and at an early age he was brought over to this country, and educated for the medical profeſſion at the univerſity of Glaſgow. Dr. Cullen being at that time lecturer of chemiſtry, Black became one of his favourite pupils, was allowed the free uſe of his laboratory, and aſſiſted him in his experiments; by which means he acquired a decided taſte for this branch of natural philoſophy. In 1754 he took the degree of doctor of phyſic in the univerſity of Edinburgh, where he had ſtudied for ſome time; and the choice which he made in regard to the ſubject of his inaugural diſſertation gave a proof of his attachment to chemical purſuits. It was *De humore acido a cibis orto et magneſia alba.* The principles of the doctrine which he brought forward in this theſis he afterwards fully explained in a paper read the next year before a ſociety in Edinburgh, and publiſhed in the ſecond volume of *Eſſays Phyſical and Literary*, 1756; containing experiments on magneſia alba, quick-lime, and alkaline ſubſtances. In this paper, by an ingenious and philoſophical ſeries of reſearches, he evidently proved the exiſtence of an aërial fluid, which he called *fixed air*, the preſence of which gave mildneſs, and its abſence cauſticity, to alkalies and calcareous earths. This noble diſcovery certainly paved the way to all that important knowledge reſpecting aërial bodies which has done ſo much honour to the names of a Cavendiſh, a Prieſtley, and a Lavoiſier, and which have made chemical philoſophy aſſume an entirely new form.

In the year 1756, on the removal of Dr. Cullen to Edinburgh, Dr. Black became profeſſor of medicine and lecturer on chemiſtry in the univerſity of Glaſgow. Next year he enriched the ſcience of chemiſtry with the curious doctrine of *latent heat*, in which he explained, in what has been hitherto reckoned a clear and ſatisfactory manner, the connection of heat with fluidity, the phænomena of freezing and boiling, and the manner in which they affect the thermometer. Theſe diſcoveries, the reſult of great natural ſagacity and experimental ſkill, certainly laid the foundation of all thoſe important facts relating to this part of chemiſtry which were afterwards brought to light by ſeveral of the moſt eminent philoſophers of the preſent period, and would alone be ſufficient to give celebrity to the name of Black. His reputation,

putation, indeed, was now raiſed ſo high, that a vacancy having taken place in the chemical chair of Edinburgh, by the removal of Dr. Cullen, in 1765, to another department, Dr. Black was looked up to as the only man capable of ſuſtaining, in this branch of ſcience, the ſuperiority which that celebrated ſchool of medicine had acquired in all others. He was therefore elected to ſucceed Cullen, and for many years diſcharged the duties of the office with univerſal approbation, being much admired for the care, perſpicuity, and elegance, with which he communicated inſtruction in his lectures, and his neatneſs and accuracy in performing experiments. Very complete manuſcript copies of his lectures were taken by many of his ſtudents, particularly in the early part of his teaching, when they contained a great deal of matter then little known to the chemical world; and theſe copies, read with avidity by the lovers of this ſcience, have greatly contributed to ſecure to him the honour of thoſe diſcoveries, and that original mode of reaſoning, which he ſcarcely ever made public in any other form.

After his election to the chemical chair, he publiſhed nothing but a paper on the Effect of Boiling upon Water, in diſpoſing it to freeze more readily, printed in the ſixty-fifth volume of the Philoſophical Tranſactions for 1774; and An Analyſis of the Water of ſome Hot Springs in Iceland, in the Philoſophical Tranſactions of Edinburgh for 1791. The latter contains ſome obſervations, highly intereſting to the chemiſt, on the formation of the ſiliceous ſtone depoſited by theſe wonderful ſprings; and has long been conſidered as a model of neatneſs and accuracy in the analyſis of mineral waters. Two of his letters on chemical ſubjects have been publiſhed by Crell and Lavoiſier.

Dr. Black was long a ſtrenuous oppoſer of the new theories in chemiſtry; but he at length became an avowed convert to the principles of the French chemiſts, and did not heſitate to make amends by his applauſe for his former oppoſition. He never diſtinguiſhed himſelf as a practical phyſician. His manners were ſimple, his temper cold and reſerved, and his habits of life adapted to his own convenience. He was never married; and died ſuddenly, in his ſixty-ſecond year, on the 6th of December 1799, his health having been in a declining ſtate for ſome time before. He was a member of the Philoſophical Societies of London and Edinburgh, and, by the ſolicitation of Lavoiſier, had the diſtinguiſhed honour of being choſen one of the eight foreign members of the Academy of Sciences of Paris.

XXV. *On*

XXV. *On the Means to be employed for multiplying Fiſh. By* C. Nouel, *Member of the Jury of Inſtruction at Rouen* *.

PERMIT me to call your attention, and that of your readers, to the advantages which might reſult to France by encouraging the multiplication of fiſh; a branch of public œconomy too much neglected, notwithſtanding the experiments of our neighbours, and the ſucceſs they have obtained. It is an unexplored mine preſented to national induſtry. What products might we not expect, if our patriotic efforts, directed towards it, ſhould have for their object an increaſe of the natural productions of our rivers; the reſtocking our pieces of water, ponds, and lakes, rendered uſeleſs by long neglect! Two methods, which might be adopted with equal facility, would conduct to this reſult. The firſt conſiſts in conveying from the lakes to the rivers, and from the rivers to the lakes, fiſh found only in one of them; the ſecond, in introducing into freſh water, as it were inſenſibly, and by means of artificial ponds, fiſh produced in ſalt water, giving the preference to thoſe ſpecies which by their habits and manner of living might be fitteſt for this kind of naturalization.

We have already had inſtances of fiſh being conveyed from one river to another, or from a river to a lake, and *vice verſa*. This method has been employed with ſucceſs in Germany in regard to the ſhad, with which ponds and pieces of ſtagnant but clear water, with a bottom of ſand and gravel, preferred by the ſhad to all others, have been peopled. In the year 1779 Dr. Bloch wrote me from Berlin that this experiment had been attended with complete ſucceſs. It is not above fifty years ago that Mr. Copland † conveyed perch into the Ken-loch and the river Urr, where they have thriven remarkably well; as has been the caſe with the trout taken from the river Leven and depoſited in Loch Long, in the county of Renfrew. The carp, which is a fiſh peculiar to warm climates, has been ſucceſſively introduced into the rivers and ponds of Pruſſia, Denmark, and England. Linnæus ſays poſitively that this fiſh formerly was not known in Sweden; and in my opinion it is ſtill unknown in Livonia,

* Tranſlated from the *Moniteur* of July 17th. Though the objects propoſed in this eſſay are applied by the author excluſively to France, it contains however a great many curious facts applicable to any other country, and therefore we have thought proper to make no alteration in the form in which the author has given it.—Edit.

† Mr. Copland of Collieſton.—Edit.

unleſs

unleſs it has been conveyed thither within theſe few years. The freſh-water gourami in the Iſle of France, where it has multiplied prodigiouſly, came originally from Bengal. It was M. Poivre, that philoſophic adminiſtrator, who had the honour of enriching the rivers of this iſland with a fiſh which in goodneſs and ſhape may be compared to the ſhad. That ſmall fiſh, the brilliant gold and ſilver colours of which all admire, the Chineſe dorado, was brought to Europe from the northern part of China. If ſo much was done for a uſeleſs fiſh, valued merely on account of its ſhining robe, by making it traverſe the ſeas to embelliſh, in compliance with faſhion, our halls and our cabinets, why ſhould we not do the ſame to obtain fiſh uſeful to man, which would recompenſe our troubles and our ſacrifices? The Romans, fated with victories and triumphs, received from tributary Aſia the rareſt ſpecies of fiſh to make a figure on their tables at their feaſts. What the Romans did for the luxury of the rich, let us do for the general good, for the utility of the poor; and let us diſtribute to every river in France the beneficent germs of a new fecundity, which will double their productions and their produce.

Our rivers do not contain more than about twenty indigenous ſpecies, and ſome migratory fiſhes, which at certain periods of the year aſcend to a certain diſtance from their mouths, or, like the ſalmon, ſwim towards their ſources as far as they can. The ſmall rivers poſſeſs ſtill fewer ſpecies; the greateſt part even are confined to the tench, the trout, eels, and ſome ſmaller fiſh of little value. How advantageous would it be to introduce into theſe rivers a multitude of foreign fiſh, which in theſe waters would find aliment more agreeable to their taſte, and which would enjoy a temperature as analogous to their wants as favourable to their reproduction?

The Seine, which I ſhall take as an example, nouriſhes many ſpecies of ſalmon and cyprini; but how many other fiſh of the ſame kind might be propagated in it! If the Seine poſſeſſes the ſalmon, it wants the thymallus, the umber of Auvergne, the lavaret, the murena of Germany, the griliſe of Scotland, the pala of Swiſſerland, the ferra of the lake of Geneva, &c. Why ſhould not the carpio of the lake di Guarda, the *ſchwarz-ritter* (charr) of the lakes of Berchſtoldgaden, an excellent kind of ſalmon, highly praiſed by baron de Moll, a naturaliſt of Salzbourg, ſucceed in France, if that bottom, which they are moſt attached to, were procured for them, at the foot of the Ardennes or the Voſgues? Why might they not be afterwards gradually introduced

troduced into our ſmall rivers? Can it be believed that the numerous tribe of the trout kind, the white, red, black, yellow ſpotted; the whitling, charr, bull, phinnoc, par, ſparling, &c. which ſwarm in the rivers in Scotland, would refuſe to ſupply our colonies with their ſpecies? No. There can be no doubt that they would bring thither that fecundity, abundance, and riches, which render them ſo valuable to their native ſtreams. The caſe would be the ſame with the *boudelles* and *büglings* offered to us by the lakes of Swiſſerland; the gudgeon, the cyprinus ballarus, and the ſalmo umbla, bred in the rivers of lower Germany. Let us open, then, with theſe countries a philoſophical and liberal exchange of the beſt fiſh of France for thoſe of which we wiſh to be poſſeſſed.

The ſecond method of multiplying the number and quantity of the natural productions of rivers, would be, as already ſaid, to convey into the freſh waters thoſe fiſh produced in ſalt water.

Nature herſelf gives us examples, and we have nothing to fear if we take it as our guide. Fiſh, originally produced in ſalt water, have voluntarily eſtabliſhed themſelves in freſh, where they have loſt all remembrance of the tumult of the waves amidſt which thoſe of their ſpecies play and ſport. Several lakes of Scotland poſſeſs ſalmon, which, abandoning their erratic taſte for a calm and ſettled life, have there become gradually naturalized. The ſalmon of the rivers Cluden and Nith, as well as thoſe of the Dee, are evidently indigenous, as is proved by their external form. The ſturgeon, the ſterlet, and different kinds of ſalmon, which Pallas obſerved in the Kama, reſide there, according to this naturaliſt, without interruption, and never deſcend to the Caſpian ſea. This celebrated traveller found the ſea-dog in the lake Baikal, though it is never caught in the Eniſſei nor in the lower Angora. He ſuppoſes, indeed, that it has been conveyed into that lake in conſequence of ſome conſiderable variation in the level of the globe, or by ſome other extraordinary event. On one hand, we ſee the *foudre*, a ſalt water fiſh, inhabit at preſent the Seine, and loſe itſelf in the banks of Tournidos, twenty-four miles above Rouen: on the other, Liancourt found the herring in the Elk, Potowmack, Hudſon's river, and the Delaware, rivers of North America; and, according to Twiſs, the ſame fiſh is caught in the freſh water lakes of Ireland: it is found in prodigious ſhoals in the baſons of Loch Lomond and Loch-Eck, in Scotland; it aſcends alſo the river Forth along with the ſalmon, and even to a very great diſtance from the ſea. In Pruſſia, it has been

ſeen in the Oder, in the environs of Stetten, at the diſtance of more than ninety miles from the mouth of that river; and I have been often told by the fiſhers of Mark and Enckhuyſen, that the herring is found in the river Vollenhoven on the other ſide of the Zuyder Zee, eſpecially towards the end of the fiſhing ſeaſon.

There is no doubt, then, that theſe different ſalt water fiſh might be eaſily naturalized in freſh water; and that the caſe would be the ſame in regard to many other ſpecies, if proper care were taken, after their removal, to beſtow on them that attention neceſſary to enſure ſucceſs to the experiment. We have a proof of this in the ponds of Eaſt Frieſland. The large plaice, tranſported thither from the North Sea, have multiplied by myriads; and they now people thoſe pieces of water which before were totally unproductive. While encouraged by thoſe examples, is there any reaſon to doubt of ſucceſs? Has not the induſtry of man, ſeconded by perſeverance, obtained reſults far more aſtoniſhing than thoſe which might be expected from ſuch experiments? By care and attention he has been able to naturalize birds of paſſage, produced in diſtant latitudes, and which are now domeſticated. Diveſting themſelves of their ſavage and free ſtate, the ſtork, the gooſe, the duck, and the ſheeldrake (*anas tadorna*), have increaſed, in the courſe of time, the number of our poultry and the inhabitants of our farm-yards. The rabbit has forgot its paternal burrows, the pigeon and the turtle-dove have deſerted the hoſpitable hollows of the oak to inhabit among us; and from this amiable bird, to that ſuperb animal which ſhares in the labours of man, how many living beings have exchanged their manners for habits and wants which we have forced them to adopt? Man, the ſovereign of nature, has not confined his dominion to that which he exerciſed over animals; and though the domain of the vegetable kingdom ſeems placed beyond the limits of his power, trees and vegetables of every kind have been ſubjected to trials and experiments, the ſucceſs of which ſeems almoſt miraculous. Guided by the ſpirit of invention, and enlightened by genius, art has every where triumphed. What has been done, therefore, for the ſurface of the earth, by collecting in different points vegetables brought from every part of the globe, and aſtoniſhed at living together, let us do alſo for the population of our internal waters.

In the year 1799 I had the honour of reading, in one of the ſittings of the National Inſtitute, a memoir on the means and advantages of naturalizing the herring, a ſalt water fiſh, in the waters of the Seine, near its mouth, &c. The account

of the proceſſes for accompliſhing this end, which I there pointed out, are not ſuſceptible of analyſis, and therefore cannot be introduced into this eſſay; it will be ſufficient for me to ſay, that the report of Lacepéde, Cuvier, and Teſſier, was entirely in their favour. At preſent, I am ſtill more convinced of the efficacy of the means which I then propoſed; and I have no doubt that, if artificial ponds were formed on the edges of rivers, the experiment would be attended with complete ſucceſs. Every man who catches a fiſh, ſays Dr. Franklin, draws from the water a piece of money. Let not the maxims and example of this philoſopher be loſt to poſterity; let them rather produce fruit, like ſtrong and vigorous ſeed ſown in a fertile ſoil. Having obſerved in New England that the herrings aſcended from the ſea into one river of that country, while a ſingle individual was never ſeen in another river, ſeparated from the former by a narrow tongue of land, and which communicated alſo with the ſea, this philoſopher took the leaves of ſome plants on which the herrings had depoſited their ova, already fecundated, and conveyed them to the river which was deprived of the annual viſit of theſe fiſh. The ſucceſs of this experiment ſurpaſſed his expectation; the ova were completely productive, and the following year the river was peopled with a numerous ſhoal of herrings, which ſince that time have continued to frequent it.

This fiſh is not the only one which I wiſh to ſee naturalized in freſh water; to the herring I ſhould add ſeveral ſpecies of the pluronectes, ſuch as the brill, the barbue, and other flat fiſh, which, poſſeſſing traits of the family of the flounder, have alſo ſimilar wants and habits: I ſhould add alſo the mullet, the goby, the whiting, the gar-fiſh, and perhaps one or two ſpecies of the gurnet. I would pay the greateſt attention poſſible to the nature of the water proper for each ſpecies. This happy choice is the principal condition, and that which could enſure ſucceſs; but I would ſelect in particular for this colonization the fiſh found in lakes, which, though little known, are more numerous than is commonly ſuppoſed, and ought to be ſo.

At the epoch of the grand revolutions of the globe, when a part of the primitive earth emerged from the middle of the ocean, and pieces of water were formed without any current, the ſpecies of fiſhes were variouſly diſperſed. Every lake in Swiſſerland and Bavaria poſſeſſes ſome ſpecies ſo peculiar to it as not to be found in any neighbouring lake. Confined within their narrow baſons, theſe inſulated ſpecies lead a melancholy vegetative ſort of life, almoſt exiled from the

world. It is therefore through a very juſt predilection for theſe fiſh, priſoners in their lakes, that they ſhould be the firſt employed for the execution of my plan.

This plan, indeed, would be attended with two advantages, beſides the increaſe of proviſions, which would at length be the reſult of it. 1ſt, The increaſe in individuals, as in ſpecies, would neceſſarily introduce œconomical ways of preparation, to render the uſe of theſe fiſh more general and more extenſive. Many of thoſe conſumed freſh, would be ſalted, pickled, or dried, with ſucceſs. The Scots grilſe is exported to diſtant countries. Salmon, ſmoked after the manner of the Livonians, is in great requeſt at Hamburgh, though there are fat ſalmon in the Elbe. The gudgeon would be dried, as is practiſed in the Iſle of Oëſel; the plaice, the brill, and the ſole, according to the Dutch method of Katwyk, imitated on the banks of the Volga in drying the bream, &c. The *boudelle* would be pickled along with the ſhad. Pallas ſays that the latter is very proper for being ſmoked; and on this occaſion he mentions the Mardouan-Tſchouvaſches, who dry in the open air ſuch of theſe fiſh as they are not able immediately to conſume. All fiſh of the ſalmon kind, the ſparling excepted, and many of the genus of the cyprinus, would be ſuſceptible of different kinds of preparation, which would give them an additional value in commerce.—2d, If ſociety in general, on the one hand, gained an increaſe of proviſion; ſcience, on the other, would derive great advantages in regard to the improvement of phyſical knowledge. More ſpecies being collected, they would be leſs apt to eſcape the eye of the obſerver, who would thus be better able to examine every thing intereſting in theſe animals in regard to their organization, nutrition, multiplication, and habits, and to whatever conſtitutes their harmonies and contraſts. We are little acquainted with the induſtry of fiſhes; they are too far beyond our reach. We do not, however, preſume, as was ſaid very juſtly by Bonnet, that all their employment is confined merely to eating each other.

Let us procure, then, theſe fiſh: it is well known that in Germany fiſh are tranſported alive to a diſtance of ſixty miles and more. Let us place theſe adoptive ſpecies in convenient ponds, where they will forget their lakes; where they will find their accuſtomed food, tutelary ſhelter, and thoſe aquatic herbs the ſhade of which they were fond of in the days of their infancy, and which will invite them to reproduce in their turn. Hot beds are formed for vegetables; let us form a new kind for fiſhes. A moderate ſum will be ſufficient to

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enable us to collect a great many ſpecies; and we ſhall ſoon be paid, with intereſt, for our expenſes and ſacrifices. Fiſhery is the agriculture of the waters: the fiſhes themſelves will be at the trouble of ſowing the ſeed, and man will have nothing to do but to collect the harveſt.

XXVI. *Some Account of the natural Productions of the Iſland of Ceylon, particularly in the Environs of Columbo. By a Gentleman now reſident on the Iſland.* 1800 *.

THE grain and fruits which are common to the peninſula are found in Ceylon.

Of rice there are four kinds, three of which are cultivated on the mountains, and do not require continual inundation. That this nutritious and wholeſome article is not ſuperabundant in the kingdom of Candy, ariſes from the imperfections of its government. If its growth were properly encouraged, this country, inſtead of having recourſe to Bengal for ſupplies, might be enabled to export large quantities of this grain.

The cocoa-trees are very numerous within the diſtrict ſubject to the Britiſh government, and from whence the coaſts of Malabar and Coromandel are ſupplied with ſpirits diſtilled from their fruit. In Candy this tree cannot be cultivated, from the great number of elephants which inhabit the woods, and are forbidden to be deſtroyed by order of the king.

The areka-tree is ſeen in every part of the iſland, and a clandeſtine trade is carried on with the Candian country, in the nuts which it yields. Theſe, with ſuch as are produced in the part ſubordinate to the Britiſh government, form a conſiderable branch of commerce.

This tree finds an enemy in the government of Candy, which diſcourages its cultivation; but the ſoil is ſo favourable to its growth, that it may be ſaid to flouriſh, in ſpite of the elephant that tramples on it, and man who neglects to preſerve it.

The coffee which is produced here, approaches in flavour to that of Moca.

Though the quantity of ſugar-cane planted at Calitura is very ſmall, and is only employed to procure ſpirits, it is ſufficient to prove that, if this neceſſary article were encouraged, it might be produced in ſufficient quantities to ſupply the demands of this iſland, and ſuperſede the neceſſity of importing

* From the *Aſiatic Annual Regiſter*, 1800.

it from Bengal and China. The natives, however, draw a small portion of saccharine juice from the buds of the tree called *kitoul* (the *carriotta* of Linnæus), the pith of which is but little inferior to the sago of the eastern isles.

The pepper plant flourishes here, but its fruit is not equal to that of the Moluccas: at the same time it may be considered as an important article of commerce.

The *cardamum* grows only at Matura, and a few other parts; and is inferior to that which is produced on the coast.

Though the cultivation of the sweet potatoes is very simple, the quantity produced is not more than sufficient for home consumption.

The *margora* or *agedorac* (melia of Flora Zeylanica) is considered as one of the most valuable plants that Ceylon can boast of. It is esteemed as an admirable succedaneum for the quinquina; and its leaves are so obnoxious to moths and destructive insects, that they will preserve woollen cloths, linen, and books, from being infested by them.

Fruit-trees are in great abundance, though their produce is not in general admired by Europeans, who are accustomed to those of a superior flavour. The fruit of Ceylon is however, in general, superior to that of the peninsula, particularly its lemons, oranges, and *pompel-mos*.

The *goraka* is a pulpy fruit, whose flavour is blended with an agreeable acid. It is of a round shape, and deeply indented. The peal is employed as a culinary article by the natives. The tree that bears it exudes a yellowish resin, which produces a tolerable varnish. This tree has been generally confounded with the *gockat*-tree, that distils the *gamboge*, and from which several hundred weight of this gum might be annually drawn. There is also a great variety of trees which grow spontaneously in the woods: they bear different fruits, though generally more or less of an acid taste, and much used by the people of the country in the confectionary, which forms such an important article in their entertainments.

The *nux vomica*, which must be ranked among the poisonous plants, is a native of this island; but is applied to no use whatever. In the same class may be placed the *palma christi*, from whence the castor oil is extracted; which forms a small article of trade.

The *hané* is a kind of pulse, and might be rendered an article of very great utility. The stem of this plant is from three feet and a half to four feet in length, and furnishes a flax, which is twisted into a long rope. It is particularly employed by fishermen for their nets and lines, from the extraordinary

extraordinary quality it poſſeſſes of never decaying or rotting in water. It appears to be deficient in elaſticity; but that may ariſe from its never having been ſufficiently ſteeped. From ſome experiments which have been made, its ſtrength appears to be in the proportion of five to four with European cordage.

The diſtrict of Matura produces ſix different kinds of ſhrub, on which inſects depoſit the *laca*. The deſcription of this inſect by Roxburgh, in the ſecond volume of the Aſiatic Reſearches, is very correct. The Ceylon *laca* is the ſame as that which is found in Pegu; but, though it is found in great abundance on the ſhrubs where it is depoſited, the inhabitants collect no more than is neceſſary for their particular uſe.

The plantations of cinnamon abound with a plant which delicacy forbids us to deſcribe. It is called *baudurá* by the Cingaleſe, and has received the ſcientific denomination of *neſſeuthes diſtillatoria* by the botaniſts. It is inaccurately repreſented by Burman, and in Pennant's View of Hindoſtân. It has been equally conſidered and examined by the antiquarian, the man of letters, and the botaniſt. It flouriſhes beneath the ſhade of the cinnamon-tree, whoſe culture it interrupts.

The trees and plants in Ceylon are very numerous. In the diſtrict of Columbo alone, there are not leſs than three hundred ſpecies. Many of them appear in the very inadequate catalogue of Palus Hermanus; from whence they have been transferred, without any diſtinctive deſcription, to the Theſaurus Zeylanicus of Burman, and ſo on, to the Flora Zeylanica of Linnæus, and other botanical works. Indeed, of one hundred Cingaleſe names given by Hermanus, and adopted by Burman and Linnæus, there are not ten in uſe among the natives; and the reſt are almoſt unintelligibly rendered in the German orthography.

Of the timber uſed in domeſtic articles, &c. thirty-nine of the moſt remarkable ſpecies have been collected. Among them the *kaloumidirié* is diſtinguiſhed by very fine black and yellowiſh veins; the Europeans call it *caleminder*. The *kadhumbirié* has the ſame ſtreaks as the former, but not quite ſo large. Very beautiful articles of furniture are made of them both.

There are alſo the ſatin wood, called *bourouth*; the *tekía*, or *teak*, employed for maſts, and every kind of ſhipwright's and carpenter's work; the *jack*, one of the bread-fruit trees, the wood of which, when freſh, is of a beautiful yellow, but changes in the courſe of time to a reddiſh hue; and the

nedoun, or *nindow*, which is very ſtrong. The two laſt are employed in furniture and domeſtic uſes. To theſe may be added the *nuga gaba*, the ebony, &c.

The elephant muſt take the lead among the quadrupeds in every part of the world which it inhabits. In Ceylon there are two ſpecies; the one called *alleia*, which has no teeth, or at leaſt very ſmall ones; and the other called *aeta*, which has teeth of a conſiderable length. In the interior parts of the iſland they are very numerous; and there are a ſufficient number of them in the Engliſh poſſeſſions to do conſiderable miſchief to every kind of agriculture.

The royal tiger is not an inhabitant of this iſland; but the leopard is very common, and ſome of them have been taken that meaſured five feet in length.

There are two kinds of wild cat, one of which is not generally known, or, at leaſt, has been very imperfectly deſcribed.

The wild buffalo is found in the foreſts, and is as furious as that of Bengal.

The wild boar is equally dangerous with the buffalo, and the woods alſo abound with them.

There is the *axis*, or Ganges deer, and a ſtag whoſe colour is gray, tinged with a ſhade of red. It bears a greater reſemblance to the hart of Corſica, than to any other of its claſs.

Of monkeys, there are three peculiar kinds, with long tails, and pouches under the chin. The hair of one is of a reddiſh hue, and that of the other two is very long: the one is white, and the other black; but all of them have long beards, which ſpread over their cheeks. They are very ſagacious, well-tempered, and tractable, as well as full of trick and amuſing playfulneſs.

The ſloth is not very common; it is from ſeven to eight inches in length, and is born with a thick covering of hair.

The *pangotin* is very common in Ceylon, and called *kabal-vaeïa*. It is accurately deſcribed by ſeveral naturaliſts; but the print of it, in Buffon, is ill deſigned. It is there repreſented as walking on its fore-feet, in common with other quadrupeds; whereas it actually walks on the *metatarſus*, turning the toes downwards. This animal can never be preſerved alive, from the impracticability of providing a ſufficient quantity of ants (which are its only food) to ſuſtain it.

There is alſo the *viverra ichneumon*, which, by the Europeans, is called *mongoos*. It has been generally believed that this animal inſtinctively applies to the medicinal aid of a certain plant, which acts as a counter-poiſon when it has been bit by a ſerpent. The natives, however, are not acquainted

quainted with any plant that poſſeſſes this ſalutary quality. It is, nevertheleſs, aſſerted by them, that the *mongoos* has been ſeen to attack the *cobra di capello*; when, though ſeverely bitten, it has killed the ſerpent, and eaten a part of it, without any viſible effects of poiſon.

Of ſquirrels there are two ſpecies. One, which is called *laéna*, has a red noſe quite flat, and long black tail, which is only found in the woods; the other, called *dandu laéna*, with yellow longitudinal ſtreaks, frequents gardens, where it deſtroys every kind of fruit.

The hares are large, but inferior, as a food, to thoſe of Europe. There are otters, but they are very rare, and ſeldom ſeen. The porcupine is to be found every where in the woods, and may be readily tamed into all the familiarity of a domeſtic animal.

There are two ſpecies of rats, which infeſt the houſe and the garden: one of them is called the *muſk-rat*, which is ſo well known in the peninſula.

There is one of four ſpecies of bats known here, which is called the *flying fox*; its French name is *rouſſette*: it is well known in the peninſula, and feeds only on fruit.

The birds are among the moſt beautiful productions of this iſland; but their prevailing haunts are in the eaſtern parts: the number of them is comparatively ſmall in the vicinity of Columbo. Not more than thirty ſpecies of them have been aſcertained ſince the Engliſh have become its inhabitants. Among theſe are the pelican, the flamand, the great and ſmall Greek pigeon, the *rollieu* of Mindanao of Briſſon; a beautiful cuckoo, with variegated plumage, called *kouroulongſia*; the maynat; two fly-catchers, with two long feathers in the tail, the one with a black head and white body, the other with a blue head and reddiſh back; and an abundance of woodpeckers, with golden plumage.

Among the fiſh which have yet been obſerved, and are not generally, if at all, known, is a ray, with a projecting ſnout like that of a dog, and of a brown colour, with a green tinge on the upper ſide. The fiſhermen appear to have a knowledge of the cramp-fiſh.

The number of ſerpents is very great, and the larger part of them are of a poiſonous nature; nor can they be generally known, as none of them exactly correſpond with the prints of Ruſſel.

The *cobra di capello*, which is a well known and moſt formidable reptile, is a native of Ceylon. It has a broad neck, and a mark of dark brown on the forehead; which, when viewed

viewed in front, has the appearance of a pair of ſpectacles; but, being regarded from behind, is like the head of a cat. Its back is of a gray colour, and has ſome duſky ſpots on the belly. No other kind of this ſerpent has been ſeen here. The natives conſider it as an object of veneration, and do not ſuffer it to be deſtroyed. It loves to inhabit dilapidated buildings.

The largeſt of all the ſerpents is the *pimpboura*. The writer of this memoir has ſeen one preſerved in ſpirits, of eight feet and an half in length, and thirteen inches in circumference, which was quite young. It is this ſpecies that is accuſed of ſwallowing bullocks and buffaloes. But, however that may be, the Cingaleſe aſſert, in the moſt poſitive manner, that there are ſerpents which are ten inches in diameter, and that ſome have been taken with a hog in their belly. Nay, it was declared, with equal ſolemnity, that one of them had been opened, in which was found the horn of a buffalo.

The moſt curious ſerpent of this iſland is the *potanga*, which is ſaid to grow to a moſt enormous ſize. One of theſe, when only four feet and a half in length, and half an inch in diameter, had ſeven young ones in it. Theſe two ſpecies are remarkable for two ſhort thick prickles, contiguous to the anus.

There is alſo the *depatnaïa*, a third kind of the *anguis* of Linnæus. Some have deſcribed it as poſſeſſing two heads. It appears to conſider its tail as a defence, from the violence of its motion whenever it is attacked.

The fiſhermen caught an extraordinary ſerpent, ſome time ſince, at ſea, of the length of fifty-ſeven inches and a half, of which there does not appear to be any deſcription in any work of natural hiſtory; though Pennant's View of Hinduſtân contains an account of one that bears ſome ſmall reſemblance to it.

Of the lizard tribe, the crocodile is the moſt conſiderable; it is the inhabitant of all the lakes and rivers in Ceylon, but is ſeldom ſeen in the vicinity of the ſea. There are two kinds of *laguna*; one of them is ſeven feet long, and is ſuppoſed to be the ſame as that which is ſo well known on the coaſt of Coromandel. There is alſo a ſmall lizard with a prickly back, like the camelion: to which may be added a ſmall ſpotted lizard, which, from its meaſured and tuneful cry, has acquired the name of the *ſinging lizard*; and the real camelion.

The toads are not of a large ſize, like thoſe of Bombay.

The inſects are innumerable. The genus of the *ſcarabæus* is the moſt abundant, but that of the *mantis* of Linnæus is the moſt curious. The ſhapes it produces are very various and extraordinary. One of them, of which Colonel Agnew made

made a drawing, is called the *animated leaf*, from the reſemblance of its wings to the leaf of a tree.

There are five ſpecies of the golden-coloured *coccinelle* of Linnæus.

A graſshopper, with black, prickly, tuberculous horns, terminated by two large yellow knobs.

A ſpider, whoſe venom and bite are as potent and dangerous as thoſe of a ſerpent: fortunately, this inſect is very rare.

A black hairy ſcorpion, about four inches in length.

Of butterflies there are about twenty ſpecies, ſome of which are well known.

The *phalæna*, a ſpecies of which is to be found in a treatiſe publiſhed in France on foreign butterflies.

The *termes*, or what is called the *white ant*, infeſts this iſland as well as the peninſula.

Laſtly, There are a great number of ticks found on different animals, ſuch as the rat liguana, water birds, pangolin, &c. The tick found on the rat is remarkable for the extraordinary manner in which it moves, having its mouth and belly turned upwards.

The ſhore of Trincomalée abounds in ſhells; but they are all mentioned in Rumphi's work on Conchology.

With reſpect to pearls, it may be obſerved, that the ſhell in which they are found is a mytilus, and not an oyſter. The deſcription of it is very correctly given in the Aſiatic Reſearches. All banks are not equally productive of the pearl; for, though the ſhells in which it is generally found are very plentiful on the Chilau banks, there is very ſeldom found a ſingle pearl in them; whilſt, further up the gulph, a pearl is found in almoſt every ſhell of a certain ſize that is opened.

There are the common cryſtallizations of ſapphires, rubies, topazes, kouroundous, tourmalines, and rock cryſtals.

Romé de l'Iſle has given a deſcription of a precious ſtone that unites two diſtinct colours; and ſuch a ſtone is ſaid, and generally believed, to have been found by the adigar, or prime miniſter, of the king of Candy, on his return from an embaſſy to Columbo: it unites the colours of the ſapphire, the ruby, and the topaz. The account adds, that it was inſtantly preſented to the king.

The ſoil around Columbo is a brittle clay, with a mixture of ferruginous particles. It is generally covered with a ſand, whoſe fertility is equal to that of the richeſt earth. On the ſea ſhore, and in ſome diſtinct parts, there are hillocks of a dark gray earth, which appear to compoſe a ſtratum immediately beneath that already mentioned.

There

There is every reaſon to ſuppoſe that there are extinguiſhed volcanoes in Ceylon, from the ſpecimens of volcanic ſtores which have been collected at Trincomalée. This opinion is ſupported by the account, that there is a lake near the ſummit of Adam's Peak, whoſe height is conjectured to be 1500 fathoms above the level of the ſea. It received this name from the Portugueſe; but the Cingaleſe call it *Sanamalé*. According to the tradition of the country, it was Buddah, the founder of the government, and to whom the inhabitants pay almoſt divine honours, who left the mark of one of his feet on this mountain, while the impreſſion of the other was found in Siam.

TABLE *of Obſervations on the general ſtate of the Atmoſphere in Columbo, which proves the unexampled uniformity of its Climate, both as to its temperature and the regular denſity of the Air. The variation of the barometer in twelve months is only* 0·36 *of an Engliſh inch, and that of Fahrenheit's thermometer only* 13 *degrees.*

COLUMBO, Iſland of CEYLON.

	BAROMETER.				THERMOMBTER.			
Months.	Highest Point.	Lowest Point.	Difference.	Mean.	Highest Point.	Lowest Point.	Difference.	Mean.
Nov. 1798 .	30.160	29.940	0.220	30.053	82. 0	77. 0	5. 0	79.41
December . .	30.128	29.988	0.200	30.057	81.50	75. 0	6.50	78.77
Jan. 1799 .	30.114	29.988	0.076	29.952	80.75	75. 0	5.75	78.29
February . .	30.090	29.940	0.150	30.020	82.50	76. 0	6.50	79.93
March . . .	30.114	29.914	0.200	30.020	86. 0	80. 0	6. 0	82.71
April	30.124	29.920	0.204	30.004	85.50	79.50	6. 0	82.71
May	30.062	29.912	0.150	29.959	86. 0	80.50	6.50	83.28
June and July	No obſervations . .		. . . .		. . .	. . .	. .	. . .
Auguſt . . .	30.064	29.976	0.880	30.030	84. 0	82. 0	2. 0	82.67
September .	30.070	29.940	0.130	30.013	82.50	78.25	4.25	80.40
October . . .	30.070	29.970	0.092	30.027	82.50	80.25	2.25	81.12
November .	30.080	29.900	0.180	29.979	83.50	79.50	4.50	80.83
December . .	30.150	29.800	0.350	30.002	82.50	73.50	9.50	79.90
Average for 12 Months,	30.160	29.800	0.360	29.980	86. 0	73. 0	13.0	79. 5

XXVII. *Me-*

XXVII. *Memorandum reſpecting the Hunting Eſtabliſhment of Tippoo Sultaun, at Seringapatam; with an Account of the Chetas ſent to his Majeſty, and now kept in the Tower, London* *.

THE principal amuſement followed by Tippoo Sultaun, at Seringapatam, for ſeveral years, was to hunt antelopes with chetas †. His predilection for this diverſion was manifeſted in the precautions taken to preſerve the game, and the attention paid to render the ſport as perfect as poſſible. A conſiderable tract of ground to the ſouth-weſt of Seringapatam, and called the *rumna*, was excluſively appropriated for the maintenance of the game, and guarded with the utmoſt vigilance. There were ſeveral hunting bungalows ‡ in different parts of the rumna for the ſultaun to retire to after the fatigues of the day. To each of theſe was attached a ſmall eſtabliſhment of ſervants, who were reſponſible for the care of the buildings and gardens §. The number of chetas in Tippoo's poſſeſſions at the period of the capture of Seringapatam amounted to ſixteen; the greater part of them were well trained. Each cheta had an eſtabliſhment of four men ‖, one cart, and four bullocks; and the whole were under the ſuperintendance of a meer ſhikar, or chief huntſman, with a certain number of aſſiſtants.

Whenever Tippoo determined to take the amuſement of hunting, one day's notice was generally given to the huntſmen, to prepare the chetas and bullocks; and on the evening preceding the day appointed for this amuſement, ſix or eight chetas were carried out to ſome village near the ſpot of the rumna fixed on as the rendezvous for the hunters. At day-break the following morning, the ſultaun, accompanied by one or two of his ſons, and ten or twelve favourite noblemen, proceeded to the rumna. On theſe excurſions he was attended by a few horſemen, and ſome officers called Moota-

* *From the ſame.*

† A ſpecies of ſpotted tiger, and known, in the relations of travellers, under the name of hunting leopard.

‡ A name uſed in India for a ſmall light building.

§ Each of theſe gardens contained four ſmall but neat buildings, regularly diſpoſed, and fronting each other; the ground between them being laid out in walks of cypreſs trees. The ground adjacent to the buildings was alſo laid out in gardens; and the whole was ſurrounded by a thick hedge, through which there were entrances and gates.

N. B. The ſultaun choſe whichever of the buildings he preferred, and the party took the others.

‖ One huntſman, two keepers, and one bullockman.

furrikas,

furrikas, (independent officers, not belonging to any corps,) who were conſtantly attached to the ſultaun's perſon, and remained near him on all occaſions, both at the palace and in the field. Very little ſtate was obſerved, and no perſons were preſent but thoſe who received particular invitations. The ſultaun generally reached the rumna about ſix o'clock, and then immediately the hunt took place as follows:

Each cheta was carried on a light cart, drawn by two bullocks regularly trained for the purpoſe. The huntſman of each cheta was ſeated on his reſpective cart, and the other attendants ran cloſe to it on foot. The carts followed each other in regular ſucceſſion, the meer ſhikar conducting the leading cart. The cheta was hood-winked, and all the ſpectators and ſportſmen kept cloſe to the carts, and endeavoured to preſerve ſilence in order not to alarm the game.

The huntſmen followed any direction acroſs the country which they thought proper. On diſcovering a herd of deer, they proceeded with more caution, and endeavoured to take up ſuch a poſition as ſhould oblige the antelope, when chaſed, to run up hill, or over broken ground; in either of which caſes, the probability of ſucceſs is much in favour of the cheta. When they arrive within four or five hundred yards of the game, the men on foot turned the cheta's head towards the antelope, uncovered the cheta's eyes, and then let him looſe.

The great aim of the cheta is to place himſelf exactly behind his prey; and the ſkill and caution he diſplays in attaining his object, conſtitutes one of the principal beauties of this diverſion. The cheta continues to be very cautious till he is within two hundred yards of the antelope; he then gets bolder, begins to run, and follows his prey with the greateſt rapidity for about three or four hundred yards, when he is either ſucceſsful, or gives up the chaſe. In the latter caſe, he generally moves about ſlowly, and prowling, till his keeper comes up: the cheta then ſuffers himſelf to be hood-winked, and conveyed back to the cart. If the cheta has been ſucceſsful, after ſeizing the antelope, he holds it by the neck with his mouth, in ſuch a manner as not to hurt it, and keeps the prey down on the ground in this poſition until the keeper arrives: he is then hoodwinked; the throat of the antelope is cut, and a leg or two given to the cheta as his reward; after which he is carried back, without any difficulty, to the cart. If it ſhould be wiſhed, however, the antelope may be taken alive * from under the cheta, who,

* This is ſeldom practiſed, and requires management and confidence in the huntſman.

when

when hoodwinked, is perfectly manageable. The ſpectators keep at a proper diſtance till the huntſman has covered the eyes of the cheta, but they may always chooſe their ground in ſuch a manner as to ſee the whole of the hunt.

A cheta will run two or three times in a day, and often is ſucceſsful in every chace. He always ſelects the largeſt buck of the herd, though it ſhould not be in ſo favourable a poſition for his purpoſe as many other ſmaller deer. In large herds, two or four chetas are let out, and then the ſport is highly diverſified and intereſting.

After hunting until ten or eleven o'clock, the ſultaun retired with the party to the next bungalow, where he paſſed the remainder of the day, and in the evening returned to his palace in Seringapatam.

A Deſcription of the Cheta *.

The cheta is the animal mentioned by Tavernier, Bernier, and other eaſtern travellers, under the name of the *hunting leopard*. It differs, however, from the leopard properly ſo called, in the following particulars:

Firſt, in ſhape.—It is of a long make, narrow deep cheſt, and ſlender waiſt. Its legs alſo are very long in proportion to the body; in which particular, as well as in its general form, it bears a greater reſemblance to the gre-hound than to its *congeners* of the feline tribe.

2dly, The ſize of the cheta's head is ſmaller in proportion to its body than that of the leopard, or of moſt other quadrupeds. The colour of the iris is of a deeper yellow than in the leopard, and its face is diſtinguiſhed by a dark line reaching from the corner of the eye to that of the mouth on each ſide.

3dly, The hair on the throat, breaſt, belly, and the under ſide of the tail, is much longer than on the other parts of the body; it is of a duſky white colour, with few or no ſpots. The hair on the upper part of the neck, and on the ſhoulders, is alſo ſomewhat longer than on the body, though not ſufficiently ſo to entitle the cheta to the ſpecific name of *Felis Zubata*, which Linnæus has given it.

4thly, The ſpots on the cheta, inſtead of being diſpoſed in circles like thoſe of the leopard and panther, are each diſtinct. The body and limbs, excepting where the long hair extends, are thickly covered with theſe ſpots, varying in ſize, of a dark colour, and a round or oval ſhape, on a light

* This deſcription was written by J. Fleming, Eſq. of the Bengal Medical Eſtabliſhment; and the other parts of the memorandum, by Capt. Sydenham.

tawny brown ground. The ears, which are ſhort and round, are each marked behind with a broad dark bar; and the tail, which is long, ſlender, and ſomewhat buſhy at the end, is marked with four ſuch bars from the tip upwards.

5thly, The laſt and principal difference between the cheta and leopard is in reſpect to diſpoſition. The leopard is incapable of being tamed, and always retains its fierce malevolent habits. The cheta is eaſily broken in, and trained for the chace. I have never ſeen one, however, that could be ſaid to be thoroughly tamed. It ſtill retains ſome ſhare of its natural ferocity and treachery, which it betrays by its reſtleſſneſs, the obliquity of its movements, and the duplicity of its looks. It ſuffers no one to approach it familiarly but its keeper, and even he careſſes it with caution and diffidence. It muſt be led to the chace chained and hoodwinked; and all that can be expected from it, even when it has been carefully trained, is, that it ſhould return quietly to its keeper when the chace is over.

The ſize of a full grown cheta is as follows:

	Ft.	In.
Length from the noſe to the tail	3	8
Length of the tail - -	2	3
Height at the ſhoulder -	2	4
Height at the rump -	2	3

Mr. Pennant's deſcription of the cheta (Hiſt. of Quadr. vol. i. p. 284) is tolerably correct; but his figure is a very bad one, and conveys a very erroneous idea of the ſhape of the animal.

The chetas preſented to his majeſty by the court of directors, were caught in the woods near Rydroog. They are about three years old *, were trained at Seringapatam, and have been frequently hunted by Tippoo Sultaun.

Their daily food is ſix pounds of mutton, with as much water as they can drink. This allowance is ſometimes varied to three fowls. A *maſſala*, or mixture of ſpices, is given to them once a day with their food, and ſerves to keep them in health and ſpirits.

Each cheta has two keepers; and one cart, with two trained bullocks, was ſent at the ſame time as a ſpecimen of the carts uſed at Seringapatam. The cart ſent to his majeſty was actually one of the ſultaun's, and has frequently been uſed by him; and the bullocks were alſo part of his hunting eſtabliſhment.

* Now about *five*.

XXVIII. *Pro-*

XXVIII. *Proceedings of Learned Societies.*

FRENCH NATIONAL INSTITUTE.

THE Inſtitute, in the public ſitting of July 4, propoſed the following queſtions as the ſubject of prizes:

PRIZE QUESTIONS.

Mathematics.—To determine the means, as far as poſſible, for leſſening the lee-way of a ſhip of war when ſailing on an oblique courſe, by combining together the manner moſt favourable for that purpoſe, the form of the keel, the draught of water, the poſition of the main beam, and ſtability.

In the year 1793 the Academy of Sciences propoſed this as the ſubject of a prize for 1795; it was ſuppreſſed before any paper was received in anſwer to it: but the Claſs of the Mathematical and Phyſical Sciences, being deſirous to fulfil the engagement contracted by the Academy, and conſidering, beſides, that this ſubject is of great importance for the navy, have thought they could not do better than to propoſe it again.

The Claſs are too ſenſible of the difficulty attending this problem to require or to hope for a ſolution from theory alone, but, without preſcribing rules in that reſpect, they invite learned navigators to treat the queſtion principally by means of obſervations, deduced either from their own experience or taken from thoſe journals in which the commanders of veſſels give an account, at the concluſion of a campaign or the end of a voyage, of the circumſtances which have occurred in regard to the rate of ſailing of their reſpective ſhips.

The prize will be a gold medal of the value of a chiliogramme, and will be decreed in the public ſitting of Meſſidor 5, an. 11 (July 4, 1803). The anſwers will be received till the 1ſt of Germinal, an. 11, (March 22, 1803,) and not beyond that period.

Phyſics.—The Claſs of the Phyſical and Mathematical Sciences of the Inſtitute, charged with propoſing, for the year 9, the ſubject of a prize, think it their duty to adopt a queſtion the ſolution of which muſt accelerate the progreſs of an intereſting part of natural hiſtory. The ſcience of organized bodies conſiſts, in a particular manner, in a knowledge of their organization, which is diſtinguiſhed into internal and external. The external ſigns, called *characters*, the firſt ſtudied and the firſt known, are of uſe to indicate the internal organization, from which they are derived, and which always ought to have an influence on their exiſtence. Theſe two parts of the ſcience intimately connected, tend mutually to

throw light upon each other. Thus anatomy furniſhes zoology with the baſes of its grand diviſions; it affords it the means of characterizing, with preciſion, the different claſſes and families of animals, and of explaining the cauſes of their manners and habits, and of the mode in which they feed.

The philoſophy of vegetables ought to render the ſame ſervice to botany. By the exertions of Grew, Malpighi, Liewenhoek, Duhamel, Bonnet, Sennebier, and other reſpectable philoſophers, it has been already enriched with a great number of inſulated obſervations, which may ſerve as guides in future reſearches. It has exhibited to us in thoſe of C. Desfontaines, the difference which exiſts in the diſpoſition of the ligneous and utricular parts of the monocotyledon and dicotyledon plants. This labour, which has enabled the ſcience to make a great progreſs, deſerves to be followed in the ſubdiviſions of theſe two grand claſſes, and in the plants known by the name of *acotyledons*, compoſing the cryptogamia ſyſtem of Linnæus. We muſt aſſure ourſelves, by ſtudying the internal organization, whether the latter ought to continue to form a third diviſion, or whether they ought to be joined to one of the other two. The ſcience has ſtill a great intereſt to determine the internal ſtructure of vegetables compoſing the grand families acknowledged by all botaniſts. It ought to verify, whether each of them has a peculiar internal organization, common to all the plants of its order, and different from that of the other families. It will endeavour to diſcover their affinity determined according to their external characters, and confirmed in the ſame degree by inſpecting their internal organs. It will examine what cauſe determines the union or ſeparation of the ſexes; the exiſtence or non-exiſtence of the corolla; the unity or plurality of its parts; the number and relative ſituation of its ſexual organs: in a word, the characters of the firſt line, derived from the eſſential organs, are invariable in all the known families. Theſe grand external differences are the conſequence only of a concealed compoſition, which it is neceſſary to unveil. The firſt diſcoveries pave a way to new ones, and the ſecondary differences will ſucceſſively become objects of attention when the firſt have been confirmed.

From theſe conſiderations, the claſs, circumſcribing their views, reduce their queſtion to the following:

To eſtabliſh the general relations which exiſt between the internal and external organization of vegetables, particularly in the grand families of plants, generally acknowledged by all botaniſts.

The authors are requeſted to accompany their deſcriptions with drawings, carefully repreſenting the organs deſcribed; and

and to confine themſelves to a ſmall number of families, multiplying the examples in each. They ought, above all, to inſiſt on the relations and differences of the families diſtinguiſhed by characters of the firſt value; and they muſt avoid reducing their labours to compilations from the authors who have written on the ſame ſubject.

The prize will be a gold medal of the value of five hectogrammes of gold; it will be decreed in the public ſitting of Meſſidor 15th, year 11, (July 4, 1803). The anſwers will be received till the 1ſt of Germinal, (March 22,) year 11, and not beyond that period.

The Claſs of the Moral and Political Sciences propoſed the following queſtion:

To compare the geographical knowledge of Ptolemy, in regard to the interior of Africa, with thoſe tranſmitted to us by later geographers and hiſtorians, excepting Egypt and the coaſts of Barbary, from Tunis to Morocco.

The prize will be five hectogrammes of gold ſtruck into a medal: it will be determined in the ſitting of Vendemiaire 15th, year 11, (7th October, 1802). The anſwers will be received till the 15th Meſſidor, year 10, (July 4th), 1802), and not beyond that period.

General conditions to be obſerved by the candidates for the prizes whatever be the ſubject.

No paper tranſmitted in anſwer to the queſtions muſt bear the name of the author, but be diſtinguiſhed only by a device: a ſealed note may be attached to it, containing the device, and the name and addreſs of the author. This note will not be opened by the Inſtitute except in the caſe of the piece having gained the prize.

The anſwers may be tranſmitted to the Inſtitute, ſending the packet containing it poſt paid. They may be addreſſed alſo, poſt paid, to one of the ſecretaries of the Claſs at Paris, or be delivered into his hands: in the laſt caſe, the ſecretary will give a receipt for it. The Inſtitute informs the competitors that it can return no memoirs, drawings, or machines, tranſmitted to them; but the authors will always be allowed to have copies of the memoirs and drawings, and models of the machines. A commiſſion of the Inſtitute will deliver the gold medal to the bearer of the receipt; and, in caſe there is no receipt, the medal will not be delivered but into the hands of the author, or ſome one properly authorized to receive it.

The following account of the mathematical labours of the Claſs of the Mathematical and Phyſical Sciences during the third quarter of the year 9, was read by Delambre:

Memoir on achromatic glaſſes, adapted for the meaſurement of angles; and on the advantages which may be derived from

double refraction for the accurate meaſurement of ſmall angles: by C. Rochon.—After an intereſting hiſtorical notice, the object of which is, 1ſt, To claim the invention of achromatic glaſſes for the learned Morehall, who, about the year 1743, found means to deſtroy the aberration of ſphericity and refrangibility by employing ſubſtances of different refracting powers: 2d, To call to remembrance what we are indebted to the learned reſearches of Euler on this ſubject, C. Rochon announces that he has improved the inſtrument deſcribed in his Reſearches on Mechanics and Phyſics, printed in 783.

Beccaria has ſhown that rock cryſtal may be cut into priſms in ſuch a manner as not to produce double refraction. C. Rochon has taken advantage of this diſcovery to ſubſtitute a priſm of that kind in the room of two variable priſms of glaſs which he employed in his firſt conſtruction.

A new improvement enabled him to obtain the meaſure of angles greater than the diameter of the ſun by means of two priſms of rock cryſtal producing double refraction; when, on again examining Euler's theory on the aberration of glaſſes, he found that it was poſſible by theſe means to meaſure by his inſtrument angles of a more conſiderable extent; ſo that at preſent it can be conveniently employed for determining the reſpective diſtances of ſhips, and the greater or leſs variations of theſe diſtances: an advantage obtained but imperfectly by Ramſden's inſtrument, which is much uſed in the Engliſh and Spaniſh navies.

Deciſive experiments have proved to C. Rochon the advantages of his inſtrument over thoſe of the celebrated Engliſh artiſt. He admits the great difficulty that may ſometimes occur in conſtructing the inſtrument, to thoſe who are not well acquainted with the method of cutting rock cryſtal. He, however, hopes that this difficulty will be ſurmounted; and C. Narci, attached to the agency of the mines, has already conſtructed the inſtrument with all that degree of preciſion which can be deſired.

On the co-relation of geometrical figures: by L. N. M. Carnot.—The object of this work is to give a more clear theory of poſitive, negative, and imaginary quantities; and to furniſh more general and certain rules for the changes which a formula eſtabliſhed on a primitive ſyſtem of points and lines may experience, and of which ſome parts change their reſpective poſitions. Means are propoſed, alſo, for giving the enunciation of geometrical problems a technical form, in order to ſhorten them, and render the application of them eaſier.

To illuſtrate his method, and ſhow the uſe that may be made

made of his principles, the author applies them to a great number of theorems and propoſitions, ſeveral of which are remarkable for their ſimplicity and elegance. What he ſays of chords; the new idea he gives of ſines; and the addreſs with which he has found means to render ſenſible to the eyes, in one figure, the principle relations that exiſt between the ſine and the coſine of two angles, and the ſine and coſine of their ſum, or their difference, will be in particular diſtinguiſhed.

Memoir on the theory of the moon.—C. Laplace has collected in this memoir the moſt intereſting reſults of his analytical calculations reſpecting the theory of the moon. The equations which he found for the mean longitude, the apogeum and the node, and the happy manner in which he employed the inequalitities, either in longitude or latitude, to deduce from them the oblate form of the earth, are already known. He now announces a determination no leſs curious, that of the parallax of the ſun. Mayer made a ſimilar calculation; but, beſides that the analyſis of that great aſtronomer was leſs profound, he was far from having ſo great a number of obſervations to enable him to determine the preciſe value of the inequality which the parallax may give. He found it therefore about $\frac{1}{11}$ too ſmall; whereas C. Laplace has attained preciſely to the ſame quantity as Lexell and Lalande deduced from paſſages of Venus, that is to ſay, $8'' 6$. An aſtronomer, therefore, without going out of his obſervatory, by uniting analyſis with obſervation, might have determined what has coſt ſo many voyages to countries ſo different in climate. We muſt however obſerve, that this method would have required much more time, and that much fewer perſons would have been in a ſtate to appreciate the juſtneſs of the reſult. There is no reaſon, therefore, to regret the long voyages undertaken, nor even to prevent people from braving ſuch dangers, when an opportunity occurs. Too many different means cannot be employed to eſtabliſh truths which, on the one hand, are ſufficiently aſtoniſhing to juſtify, to a certain point, the incredulity of thoſe who refuſe to admit them, becauſe they do not comprehend the demonſtrations; and, on the other hand, are ſo delicate that one can never be certain of knowing them with the utmoſt preciſion.

Trigonometric tables.—C. Prony has read to the Claſs a memoir on a work called *Opus Palatinum de Triangulis*. Theſe tables, the moſt complete that ever appeared in regard to trigonometric lines in natural numbers, were not calculated in all their parts with the ſame exactneſs. It was ſoon found that the tangents and ſecants of the laſt degrees had

need of conſiderable corrections; it was vaguely known that theſe corrections had been ordered, but it was not certain that they had been executed.

C. Prony had the good fortune to meet with a copy of the *Opus Palatinum*, in which the tangents and ſecants of the laſt degrees were as exact as the reſt. The title of the book was augmented by the following words: *recens emendatus à Bartolomæo Pitiſco, Sileſio*, &c. The ſeven laſt degrees have been calculated anew, which rendered it neceſſary to reprint eighty-ſix pages, which may be known by ſome differences in the paper and type; the latter being more uſed, and the former leſs beautiful, than in the reſt of the volume. C. Prony's memoir contains the formulæ neceſſary for fixing the quantity of the errors, and tables of compariſon, which prove the exactneſs of the corrections of Pitiſcus.

Trigonometrical tables of Borda, publiſhed by Delambre.—Theſe tables are merely logarithmic. The decimal diviſion of the circle for which they have been conſtructed, is, without doubt, more convenient than the ſexageſimal diviſion. The celeſtial ſigns, each conſiſting of 30 degrees, which divide the circumference into twelve parts, while each degree is ſubdivided into 60 minutes, and the minute into 60 ſeconds, deviate too much from the ſimple progreſs of the arithmetical ſyſtem, which proceeds invariably by tens, not to give frequent riſe to very great inconveniences in practice.

Hiſtoire Celeſte Françoiſe. This important collection publiſhed by Lalande contains obſervations of the ſtars, made at the military ſchool in 1783 by Dagelet; and obſervations of every kind, made at Toulouſe by C. Darquier and Hadancourt in the ſpace of ſeven years, beginning at 1791. But the moſt conſiderable part of this volume is the aſtoniſhing collection of 50,000 ſtars, the fruit of the vigils and aſſiduous labour of eleven years of Michel le François Lalande, the nephew, happily ſeconded for three years by C. Burckhardt. It may readily be conceived how uſeful this labour may be in regard to comets, which in future will not aſcend in any part of the heavens without being ſurrounded by ſtars well known, and by help of which their motion and poſitions may be every moment determined. It is no leſs evident that theſe obſervations, compared with thoſe made or which may be afterwards made at different times by different obſervers, will, ſooner or later, give riſe to intereſting remarks on the changes that take place in the heavens on the new ſtars that from time to time appear, and on thoſe which loſe themſelves, or at leaſt change their ſplendour and light.

Memoir containing the ſolution of a mechanical problem

propoſed by d'Alembert: by C. F. Nieuport. The object of this problem is to determine the direction of the force which would keep in equilibrium and immoveable a body of any figure whatever, traverſed by a ſlack and flexible thread having its extremities attached to two fixed points.

The analyſis of Nieuport conducts to a reſult of which d'Alembert had only a faint idea; that is to ſay, he concludes that in all caſes the direction of the force divides into two equal parts the angle formed by the direction of the two parts of the thread which are without the body.

It reſults alſo from this analyſis, that if the groove which affords a paſſage to the thread be of a curvilineal figure, the ſolution will not be more complex, and the equation will always retain the ſame form. This d'Alembert did not venture to aſſert.

Demonſtration of a geometrical theorem on eſtimating the ſolidity of the hemiſpherical arch of Viviani: by C. Tedenat, profeſſor of mathematics in the Central School of Aveyron.—On reading the Integral Calculus of Lacroix, publiſhed a few years ago, he conceived the idea of determining algebraically, by a method of Euler, the ſolidity of that part of a hemiſpherical arch of which Viviani determined only the ſurface.

In the ſecond volume of the Memoirs of the Inſtitute for the year 6, it is ſeen that C. Boſſut had announced to the Claſs the ſolution of the ſame problem, of which he gave merely the reſult, promiſing to give the calculation on ſome other occaſion. This he indeed did ſome time after, at the end of the ſecond volume of his Integral Calculus: two ſolutions of the problem may be ſeen there; the ſecond of which is exceedingly ſimple.

C. Tedenat, having read in the above memoir this extenſion, which may be given to Viviani's problem; a circumſtance not before mentioned by any geometrician, was deſirous of proving that he himſelf had made the ſame remark, and with that view ſent to the Inſtitute the ſolution here announced, and which, in regard to the definitive reſult, is agreeable to that of Boſſut.

Longitude of Florence.—C. Lalande read a memoir on the longitude of Florence, the poſition of which was very uncertain. He has learned from new obſervations received from Ciccolini, and which he has calculated, that the difference between the meridians of Paris and Florence is 0 h. 35′ 40″.

Secular motion of Venus.—This memoir was alſo by Lalande, who has found by the laſt inferior conjunction of this planet, that the epoch of the longitude is exact as well as the equation of the orbit, and that there is no change to be

made in this reſpect in the laſt tables. In theſe calculations, C. Lalande has kept in view the perturbations which Venus experiences by the action of Jupiter and that of the earth, according to the formulæ which he gave himſelf in the Memoirs of the Academy of Sciences.

Natural Hiſtory.—C. Jurine has made ſome curious obſervations on the puce monocule, called commonly the water flea (*monoculus*), a ſmall cruſtaceous animal which abounds in ſtagnant water, and which ſometimes has given riſe to reports of ſhowers of blood, becauſe the eggs, with which it is full in the ſpring-time, give it a red colour, ſo that the water where there are a great many of theſe inſects, ſeems really to be mixed with blood.

The ableſt naturaliſts, Swammerdam, De Geer, Schæffer, and Otto Frederic Muller, have ſucceſſively ſtudied this animal; but Nature is inexhauſtible even in her leaſt productions, and C. Jurine, of Geneva, aſſociate of the Inſtitute, has ſtill diſcovered, reſpecting this inſect, a number of curious particulars which had eſcaped theſe learned naturaliſts.

The moſt ſingular fact diſcovered by C. Jurine is, that a female which has had intercourſe with the male, tranſmits the influence of it to her female deſcendants; ſo that they all lay eggs, without being obliged to couple, till the ſixth generation; after which their young periſh in moulting. Another ſpecies carried this influence to the fifteenth generation. It is well known that Bonnet made ſimilar obſervations in regard to *pucerons*. Theſe generations produced without copulation are leſs abundant, and ſucceed with leſs rapidity, than thoſe in which the males have had a ſhare.

THE FREE ECONOMICAL SOCIETY OF PETERSBURGH.

In an extraordinary ſitting of the Society on the 16th of April, which was attended by a great number of the principal members, there was read the following

Letter from his Imperial Majeſty:

"All inſtitutions eſtabliſhed for the benefit of my ſubjects ſhall always be objects of my particular attention, and therefore the Free Economical Society may rely upon having my ſupport and protection. I conſider their labours, both in regard to their object and conſequences, as worthy of reſpect; and to promote their influence on the general good, I have ordered the imperial treaſurer to pay to the Society yearly the ſum of five thouſand roubles. In regard to changing the preſent impreſſion of its medal, it is my opinion that none can be fitter for that purpoſe, or more agreeable to

the feelings of the Society, than the head of its firſt founder, by whom it was approved and confirmed; and therefore I conſider it proper that it ſhould be retained as a memorial to poſterity, and even for the honour of the inſtitution.

I remain your well wiſher,

"April 13th, 1801. ALEXANDER."

The Society, after this letter was read, voted their moſt reſpectful thanks, to be communicated in writing, to his imperial majeſty, for his having been graciouſly pleaſed to aſſure them of his protection, and for the annual ſum promiſed to enable them to proſecute their labours; that a complete collection of their tranſactions ſhould be preſented to his majeſty, and that theſe reſolutions ſhould be publiſhed.

The Society has propoſed the following

Prize Queſtion:

A great many experiments have been already made on the preparation of ſugar from white beets both in Ruſſia and in other countries; and a variety of opinions and facts in regard to this ſubject, which however are, in part, contradictory, have been publiſhed. As this ſubject is conſidered to be of great importance, the Society require a diſſertation, in which ſhall be ſhown:

What has been hitherto diſcovered with certainty in regard to the preparation of ſugar from the beet-root: what, on the other hand, is doubtful; and, in particular, what is properly the kind of beet which ought chiefly to be choſen for that purpoſe: in what ſoil, and in what manner, it can be beſt cultivated: how ſugar can be obtained from it with moſt advantage: and, whether there is reaſon to expect that the ſugar procured from it can be ſold in any of the provinces at a cheaper rate than the common ſugar?

The prize for the beſt paper on this ſubject is a gold medal of the value of 30 ducats. The papers muſt be tranſmitted to the Society, with the uſual forms, before the month of March 1802; and may be written in the Ruſſian, German, or French languages.

XXIX. *Intelligence and Miſcellaneous Articles. July* 1801.

ASTRONOMICAL NOTICES.

I. C. CAIGNE, notary, Rue de la Harpe, No. 237, is commiſſioned to pay the ſum of 600 francs to the firſt aſtronomer, French or foreign, who ſhall diſcover a comet between this

this period * and the end of the year 1801, provided it be not viſible to the naked eye, and that its appearance be confirmed by another aſtronomer; in France, for example, by one of thoſe at Paris, Toulouſe, Marſeilles, Montauban, Viviers; in Germany, by one of thoſe at Gotha, Berlin, Vienna; in Italy, by one of thoſe at Milan; and in England, by the aſtronomer royal, Greenwich.

To find a comet it is not neceſſary to be an aſtronomer, nor is it required that its place ſhould be exactly determined; it will be ſufficient to indicate nearly the hour at which it appeared, at what height above ſuch or ſuch a ſtar, or at what diſtance from the meridian; which is very eaſy. There are ſo many amateurs who look at the heavens, that there is reaſon to hope ſome of them will employ this degree of attention by conſidering that comets are at preſent the only deſiderata in aſtronomy, and that they may be found by a common teleſcope mounted on a quadrant or parallactic machine of wood, which any one may conſtruct by conſulting the rules of aſtronomy. LALANDE.

II. On the 12th of July, at ten in the evening, C. Bouvard diſcovered a ſmall comet near the head of the Great Bear. Its right aſcenſion was 111° 15′, and its northern declination 69° 30′, at 11^h 58^m of true time. It was ſmall and round, had no tail, and was ſomewhat nebulous. C. Bouvard has told me that it was ſeen by C. Mechain at a quarter paſt ten, and by C. Meſſier at half after ten. I do not yet know who will be entitled to the 600 francs which Caigné, the notary, has been commiſſioned to deliver to the perſon who ſhould diſcover a comet. LALANDE.

III. The following notice reſpecting this comet was tranſmitted by C. Mechain, to the miniſter of the interior:

"Paris, at the National Obſervatory, July 13, 1801.

"The intereſt which you take in the re-eſtabliſhment of the obſervatory, and the powerful means you procure to us to enable us to put it into ſuch a ſtate as to vie with the moſt celebrated obſervatories of Europe, render it my duty to communicate to you the diſcovery I made yeſterday evening about ten o'clock. I obſerved a new comet in the northern part of the heavens below the pole, between the conſtellations of the Giraffe and the Great Bear, and very near the head of the latter. This comet was not viſible to the naked eye, it was even very faint in the teleſcope: it had no tail

* This notice is copied from the *Magazin Encyclopédique*, 1ſt Meſſidor (19th June).

or

or train, and appeared only as a nebulous ſtar of not more than two or three minutes diameter; a little more luminous towards the centre than the edge, which was diffuſe, or not well defined.

"According to my obſervations, this comet at 12 hours mean time had 111 degrees 14 minutes right aſcenſion, and 69 degrees 31 minutes northern declination. This period was very nearly that of its lower paſſage of the meridian, where its altitude above the horizon was 28½ degrees. It appears to deſcend towards the ſouth about 3½ degrees in 24 hours, and is proceeding rapidly towards the eaſt. I ſhall follow it attentively; and, when I have made a ſufficient number of obſervations to determine its orbit, I ſhall have the honour of tranſmitting to you the reſult of my reſearches.

"If you think this notice of the appearance of a new comet worthy the attention of the Firſt Conſul, it belongs to you to preſent it to him.

"This is the third comet which I have diſcovered at the National Obſervatory ſince I entered it, after having terminated the portion of the meaſurement of the meridian, with which I had the honour of being charged; and it is the twelfth altogether that I have found without the aſſiſtance of any perſon ſince I have been employed on this part of aſtronomy.

"C. Bouvard, aſſiſtant of the Board of Longitude, who reſides alſo in the obſervatory, and who purſues with zeal the courſe of the daily and fundamental obſervations, diſcovered yeſterday the ſame comet nearly at the ſame time as myſelf, and without our having had any communication on the ſubject. MECHAIN."

IV. The comet diſcovered on the 12th by three aſtronomers at the ſame time, is a ſingularity, of which we have no example: it is the twentieth of C. Meſſier, the twelfth of Mechain, and the fourth of Bouvard. It was ſeen on the 18th near the ſtar Lambda, in the paw of the Great Bear; having moved at the rate of four degrees per day, and acquired a little increaſe of light. As it is proceeding towards the ſouth, it is probable that it will ceaſe to be viſible to us in eight days on the back of the Lion.

I had the pleaſure of finding in my 50,000 ſtars, that which was near the comet at the moment when it was diſcovered.

The notary has written to the Board of Longitude to know to whom he ought to pay the 600 francs depoſited in his hands; and has received for anſwer, that he muſt wait till it is known whether the comet has been diſcovered in any other country. July 20th. LALANDE.

CHE-

CHEMICAL NOTICES.

Profeſſor Lampadius has offered ſome ſpeculations, accompanied with experiments, reſpecting the poſſibility of decompoſing the earths and fixed alkalies. The following obſervations deſerve attention:

1. The cauſtic ſtrontian earth, barytes, and lime, are decompoſed in the ſtrongeſt white heat, by combining them with carbon; the firſt is particularly attracted by coal, and forms azote, water, and carbonic acid, during that proceſs. The decompoſition of thoſe bodies, alſo, proceeds under the blowpipe.—2. Earths poſſeſs much affinity for oxygen, which is proved by the excellent experiments of Humboldt, in decompoſing the pure argillaceous earth by oxygen gas; and it appears, from the following facts, how great the influence of oxygen is upon the earths.—3. The *fermentatio foſſilis* of the porcelain earth, according to ſome mineralogiſts, is formed by the foſſil fermentation of the fieldſpar; but it continues to be in this way decompoſed, when it is further expoſed to the action of the air, by which means it is alſo prepared for the intended uſe, loſing thus its ſandy particles, and becoming ſoft, and fit for being worked.—4. The oxidated argillaceous earth is with more difficulty diſſolved in acids than the deoxydated. Pure argil, which he happened to keep in combination with oxygen gas and water for ſix months, was not perfectly ſoluble in ſulphuric acid. The ſolution, however, proceeded, as ſoon as the earth, after being diſſolved by cauſtic lye in a ſilver crucible, was precipitated by acetous acid; by which it ſeems probable, that the cauſtic fixed alkali deprives the argillaceous earth of its oxygen in a red heat. Hence it may be explained why the ſapphire is ſoluble in acids, after being burnt with kali, &c.—5. It deſerves to be attended to, and proved by further experiments, what the late Mr. Girtanner has conjectured of the oxidation of earths.—6. The earths are formed in plants and animals from elements, which they receive with their nutriment, and through the mediums with which they are ſurrounded. The intereſting experiments of the ingenious Vauquelin on the formation of the calcareous earth in hens, are known to every chemiſt. The earths contained in plants are the ſame, even when they grow in different ſoils, from which, of courſe, they do not originate.—7. Earths are alſo formed in the atmoſphere, which appears from the late obſervations of ſtony maſſes having fallen from the atmoſphere. If we dare acknowledge hydrogen, oxygen, and azote, as the elements of the earths, that phænomenon will be eaſily explained. From theſe remarks we may

conclude,

conclude, that the analyſes, which have hitherto been made of terreous ſubſtances, are very little to be depended on. Profeſſor Lampadius is at preſent much engaged in experiments to aſcertain the nature of ſiliceous earth; which he conceives to be nothing but argillaceous earth in the higheſt degree of oxidation, and which is changed into argillaceous earth by treating it with deoxidating ſubſtances. It ſeems, therefore, probable, that ſeveral foſſils, which, according to their external or oryctognoſtic ſigns, appear to be ſiliceous, are changed in the hands of chemiſts into argillaceous earth! Though conſcious of the boldneſs of this aſſertion, the profeſſor obſerves, that in different analyſes of the ſame ſubſtances he has ſometimes obtained a greater, ſometimes a leſs, quantity of argillaceous or of ſiliceous earths, which he aſcribes to the above circumſtance. On the whole he thinks, that earths as well as fixed alkalies are compoſed of azote, hydrogen, and oxygen.

Mr. Lambe has proved, by ſeveral experiments, that the precipitate formed upon mixing muriate of lime with muriate of magneſia is carbonate of lime, which ariſes from the muriatic acid not having the power to ſeparate the laſt portion of carbonic acid from carbonate of magneſia, when affuſed on that ſubſtance to convert it into a muriate.

C. Vauquelin, in a late paper on the combination of metals with ſulphur, divides them into three orders: 1. Metals and ſulphur, or ſulphurets properly ſo called: 2. Metallic oxides and ſulphur, which ought to be called ſulphurated metallic oxides: 3. Metallic oxides with ſulphur and hydrogen. Theſe triple combinations he calls *metallic hydro-ſulphurated oxides*. It is obvious, and chemiſts ſhould remember the fact, that the action of the different acids upon ſuch compounds muſt be altered and modified according to the claſs to which they may belong.

MAN IN THE SAVAGE STATE.

A great deal has been ſaid in the journals of the ſavage child found in the department of Aveyron; and ſuch diſcoveries cannot fail of being intereſting to mankind, eſpecially if they could lead to means for civilizing and reſtoring to ſociety theſe unfortunate beings, whom nature ſeems to have cut off from the rank of men to place them among the number of irrational animals.

Such are the ideas ſuggeſted by examining the young man found

found about a year ago in the iſland of Madagaſcar, now exhibited in Toulouſe. He is of the uſual ſize, that is to ſay, about five feet eight inches in height; he is pretty ſtout, and well made in all his parts, and ſeems to be between twenty and twenty-five. The colour of his ſkin is the ſame as that of all the Europeans; which gives reaſon to think that he had been caſt upon the above iſland by ſome ſtorm during his infancy, and found means to preſerve his exiſtence by devouring whatever he could find; for he ſwallows ſtones, iron, and every thing that falls into his hands. He eats raw fleſh with unexampled avidity, flowers, herbs, and even dogs and cats, dead or alive, if given to him; but he has a great averſion to bread and dreſſed victuals, and, in general, for every thing baked, boiled, or roaſted; and this he teſtifies every time they are preſented to him, by convulſive movements and tearing his own ſkin: in a word, he always appears to be in a ſtate of ſuffering; his head is in a continual ſtate of motion, leaning alternately to either ſhoulder; he twiſts his hands, or employs them in pulling the ſkin of his breaſt with an air of grief truly affecting. His manner of ſwallowing is alſo worthy of remark: he does not exerciſe this function like other men, but, having turned the meat for a few moments in his mouth, he throws it violently into his gullet, into which it ſeems to deſcend with pain. He ſeems not to underſtand any thing ſpoken to him, and only emits a faint cry from his throat when he wiſhes to have food. Yet this being, ſo voracious, ſo well formed, and who is neither deſtitute of beard, nor hair on thoſe parts uſually covered, ſeems in other reſpects not to be a man: women have no attractions for him; and his keeper aſſerts that he never could diſcover the leaſt movement in his parts of ſex.

Such is the ſtate of this unfortunate being, who has nothing human but the form, and who in judgment and underſtanding ſeems inferior to the greater part of animals. It is ſuppoſed that the Dutch captain in whoſe ſhip he was brought to Europe, uſed him very ill: he is, indeed, exceedingly timid, and ſeems to have no other ſentiments than thoſe of hunger and fear. The leaſt threatening motion of his keeper frightens him ſo much as to produce a total change in his phyſiognomy: he can neither laugh nor weep; and employs the ſame cry to expreſs his joy when food is preſented to him, his deſire when he ſees it, and his pain when ſtruck. It has hitherto been impoſſible to accuſtom him to wear clothes; and, in order that he may be exhibited to the curious, a ſkin is faſtened around his loins: even this cover-

ing

ing he ſeems to bear with impatience, and makes every effort to tear it off. As long as he is permitted he remains lying on the ground naked, with his head low, and in a poſture which appears to be extremely conſtrained.

VOYAGES OF DISCOVERY.

I. His majeſty's ſhip the Inveſtigator, of 22 guns, which had been preparing for ſome months before, ſailed from the Nore on Monday the 20th of July, on a voyage of diſcovery to the ſouth-weſt of New Holland. She was to have ſailed ſome time ago, but it was thought adviſable to procure firſt the protection of the French government, to prevent the object of the voyage from being defeated by any of the common accidents of war; and ſome delay was occaſioned before the neceſſary papers were procured. The Inveſtigator is commanded by lieutenant Flinders, to whom the world is indebted for ſeveral diſcoveries made in that quarter; having been ſent from Jackſon's Bay, and ſailed round that country known by the name of Van Diemen's Iſland, paſſing through the ſtrait which ſeparates it from New Holland, to which he gave the name of Baſs's Strait. He is now to examine the whole coaſt of New Holland; to diſcover what large bays, but eſpecially what rivers are to be found there; as it is natural to ſuppoſe that ſo large an iſland, or, more correctly ſpeaking, ſo extenſive a continent, (being conſiderably larger than all Europe,) muſt have many ſuch, which may enable him to penetrate far into the interior.

Perſons verſed in aſtronomy, natural hiſtory, mineralogy, &c. and able draftsmen, accompany the expedition.

II. The following is an extract of a letter from captain Baudin, now on a voyage of diſcovery, dated on board *le Geographe*, Iſle of France, March 20th:

"We entered this port yeſterday; and I embrace the opportunity of a Swediſh veſſel, juſt about to ſail, to inform you of our arrival at this colony, after a paſſage of four months and two days, from Teneriffe. We have been alternately diſtreſſed by contrary winds and calms; yet no kind of malady has appeared on board either of the two veſſels, and all, without exception, have enjoyed perfect health. Our voyage, very unintereſting in regard to geography, has been highly intereſting in regard to natural hiſtory: we have collected more than two hundred new and hitherto unknown objects, which to connoiſſeurs will occaſion as much aſtoniſhment as pleaſure."

NATURAL

NATURAL HISTORY.

The following ſingular phænomenon, which muſt be intereſting to thoſe fond of obſerving nature, has been communicated in a letter from Sileſia:—Laſt year, a gooſe, like the other animals of her ſpecies, on the cauſeway of Schauris, not far from Wartenberg, placed herſelf on a neſt in the ſpring, as if with intention of laying, but produced no eggs. She, however, remained in the neſt during the whole hatching-ſeaſon; and completed that period, but without having laid. This gooſe, being killed in the autumn following, thoſe who had obſerved her during the hatching-time were much aſtoniſhed when ſhe was opened, to find in her bowels two young ones completely hatched, perfectly formed, and preſſed towards each other. They were both dead; their bodies, like thoſe of other young geeſe, were covered with yellowiſh down; and they had feathers in their wings an inch in length. Near them was a large egg perfectly hard.

GRAND JUNCTION CANAL.

An epoch of ſingular importance to the internal commerce of the kingdom in general, and particularly of the metropolis, is, the opening of this canal, which took place with great formalities on the 10th of July. This ſtupendous monument of Britiſh ſpirit was undertaken and finiſhed during the courſe of the war, at an expenſe of nearly a million ſterling. It unites the trade of the north, north-weſt, and north-eaſt, and midland parts of this iſland, with Paddington, now become *the weſtern port of London.*

TO DESTROY BLACK BEETLES.

On the cover of our laſt Number we printed a requeſt from a correſpondent to be informed whether any effectual method was known for getting houſes cleared of that kind of vermin vulgarly called *black beetles.* A conſtant reader deſires us to inform him, that if he will take ſome ſmall lumps of unſlacked lime, and put it into the chinks or holes from which they iſſue, it will effectually deſtroy them; or, that he may ſcatter it abroad on the ground, if they are more numerous there than in the holes.

XXX. *Account of the improved Pump invented by Mr.* Robertson Buchanan, *Engineer, No. 57, Piccadilly.*

THE many fatal accidents which happened to ships from the choking of their pumps, made it an important object, in naval affairs, to find some machine for freeing ships from water not liable to so dangerous a defect. The chain pump, having been found least exceptionable in this respect, was adopted in the British navy; but, as Mr. Townsend observes, "the chain pump itself is not free from imperfections. If the valves are not well fitted to the cylinder, through which they move, much water will fall back; if they are well fitted, the friction of many valves must be considerable, besides the friction of the chain round the sprocket wheels, and of the wheels themselves." To which may be added the great wear of leathers *, and the disadvantage which attends the surging and breaking of the chain. "The preference, therefore, which has been given to chain pumps over those which work by the pressure of the atmosphere, must have arisen from this one circumstance, that they have been found less liable to choke.

"In point of friction, of coolness, and of cheapness, the sucking pump has so evidently the advantage over the chain pump, that it will not fail to gain the preference whenever it shall be no longer liable to be choked with gravel and with chips †."

Buchanan's pump, which, like the common pump, acts by the pressure of the atmosphere, is not liable to the defects incident to other pumps upon that principle, being essentially different from any now in use.

The construction of this pump will be easily understood from the following short description:

Fig. 1. (Plate III.) is a vertical section of the pump, as made of metal, in which A is the suction-piece, as it is commonly called; B, the inner valve; C, the outer valve. The valves are of the kind called clack valves; their hinges are generally made of metal, as being more durable than leather; and, requiring no boxes, are peculiarly simple in their construction. D, the working barrel; E, the piston; G, the spout.

Fig. 2. is a section, by the line a b, of fig. 1. showing how

* See Captain Inglefield's Narrative.

† Townsend's Journey, vol. i. p. 171.

the lower valve B may have its ſockets formed in the flanche at the lower end of the working barrel, and therefore requiring no box. The outer valve is alſo conſtructed in the ſame manner.

The piſton E, being raiſed in the working barrel D by any of the methods practiſed with the common pump, rareſies the ſpace between the piſton and the valve B, which valve opens upwards; the exterior atmoſphere, at the ſame time, by its preſſure on the ſurface of the water in the well, forcing the water to aſcend in the ſuction-piece A, to reſtore an equilibrium. On the return of the piſton, the valve B, by its own gravity and the increaſed weight brought upon its upper ſurface, cloſes the upper oriſice of A; while the valve C, by the ſame increaſed weight acting on its inner ſurface, is forced out towards b, allowing whatever is contained between the valve B and the piſton E to paſs into the ſpout G, from whence it cannot return into the working barrel; for, the moment the piſton begins again to aſcend, the valve C, by its own gravity and by the preſſure of the atmoſphere, is forced back into its firſt poſition, and ſhuts up the communication between the ſpout and the working barrel. A few ſtrokes of the piſton exhauſt the ſuction-piece A of all the air it contains, driving it off through the valve C; the water, in the mean time, riſing in A till it paſs the valve B, and, by ſucceſſive ſtrokes, be diſcharged through the ſpout G.

It will be readily perceived that this pump, ſo far as we have deſcribed it, agrees exactly with the *common ſuction-pump* as to *its prime principle*, the water being raiſed to the height at which it is delivered *by the preſſure of the atmoſphere alone*; but that it poſſeſſes alſo important advantages in point of conſtruction. In ſhort, it has all the deſirable properties of the common pump without any of its diſadvantages, beſides poſſeſſing not a few good qualities which are peculiarly its own.

The principal object of its invention was to remove the imperfection of *choking*; and in attaining this important end, a variety of collateral advantages have alſo been produced, which enhance its utility.

The points in which it differs eſſentially from the common pump, and by which it excels, are, *that it diſcharges the water below the piſton, and has its valves, which are of the moſt ſimple and durable conſtruction, lying near each other, and of eaſy acceſs, without the diſjunction of any part of the machine.*

The advantages of this arrangement are: that the ſand, or other matter which may be in the water, is diſcharged without

without injuring the barrel or the piſton leathers; ſo that, beſides the avoiding of unneceſſary tear and wear, the power of the pump is preſerved, and not apt to be diminiſhed or deſtroyed in moments of danger, as is often the caſe with the common and chain pumps: that the valves are not confined to any particular dimenſions, but are made capable of diſcharging every thing that can riſe in the ſuction-piece, *without danger of being choked:* that if there ſhould happen upon any occaſion to be an obſtruction in the valves, they are both *within the reach of a perſon's hand*, and may be cleared at once, without the disjunction of any part of the pump. Beſides, it occupies very little ſpace in the hold, and thus ſaves room for ſtowage.

But this is not all: the pump under conſideration may be *inſtantaneouſly converted into an engine for extinguiſhing fire*, as it commands at will all the advantages which reſult from the principles on which *forcing pumps* are conſtructed. This is obtained by ſimply ſcrewing an air veſſel H on the top of the ſpout G, while the mouth of the ſpout is furniſhed with a ſtopple, fig. 3. made for receiving ſuch pipes and hoſe as are common to fire engines. This ſtopple is elliptical and tapered, and, being introduced tranſverſely, upon being pulled back becomes immediately tight.

Theſe parts being provided, all that is neceſſary to make the pump act as a fire engine, after having been uſed as a ſucking pump, is to plug up the ſpout with the ſtopple. When not wanted to act as a forcing pump or fire engine, theſe parts are not neceſſary.

The advantage to a ſhip of having a pump, which, as occaſion requires, may either be uſed for raiſing water or extinguiſhing fire *, is too obvious to require comment. It may however be obſerved, that in its latter capacity it may alſo be uſeful on ſhip-board for many common purpoſes, ſuch as waſhing the decks and ſides, or for wetting the ſails in light winds. For thoſe purpoſes clean water may be applied in various ways, but perhaps the moſt ſimple is by the ſtop-cocks, uſed in many ſhips for ſweetening them.

But this pump is not confined to nautical uſes alone; its adaptation extends to the raiſing of water in all ſituations, and with peculiar advantage where it happens to be mixed with ſand, or ſubſtances which deſtroy other pumps; as, for inſtance, in alum works, ſoap works, mines, quarries, the clearing of foundations: and in its double capacity it will be very convenient in gardens, bleaching grounds, on Weſt India eſtates, (combining a ſtill-houſe pump and a fire

* Fire engines, when wanted, are often out of repair.

engine,) in ſtable and farm yards, and in all manufactories, or other places, where there is a neceſſity for raiſing water, and the riſk of fire.

With all theſe advantages it is a ſimple and durable pump, and may be made either of metal or wood at a moderate expenſe.

No particular mode being eſſential in the working of this pump, it may, according to choice or circumſtances, be wrought by all the methods practiſed with the common pump. In many caſes, however, it may be advantageous to have two of them ſo connected as to have an alternate motion; in which caſe, one air veſſel, and even one ſuction-piece, might ſerve both.

Its principles admit of various modifications; but as what is already mentioned may be ſufficient to indicate its ſuperiority over the common and chain pumps, and the advantages likely to reſult from its general uſe, a further detail is unneceſſary. We cannot, however, diſmiſs this article without mentioning that we have ſeen two certificates reſpecting its utility at ſea, which deſerve particular notice. One of them, dated the 23d of June laſt, is from captain William Murray, of the Prince of Wales exciſe yacht, of 20 guns, who had one fixed on board that veſſel in the year 1794, which was found to anſwer ſo well, that he has ſince had a ſecond and third one: he finds that the piſton leathers are not in the leaſt hurt by ſix years uſe, and recommends the pump highly to veſſels which carry corn, or ſuch ſubſtances as are apt to choke or injure other pumps. The other certificate, dated the 14th of July laſt, is from captain Hurſt, of the Britannia of Glaſgow, but then in the Thames. He ſtates, that one of theſe pumps was fixed on board his veſſel in April 1800, and had anſwered its purpoſe in the moſt complete manner, and gives one particular inſtance in the following words:—"When at ſea, about ſix weeks ago, a quantity of coffee, by ſome means, had got into the ſhip's well. Upon trying the common pump, it was ſoon rendered almoſt uſeleſs by the coffee preventing, in a great meaſure, the valves from acting. I then tried the patent pump, which, with the greateſt facility, completely diſcharged the coffee from the well." He then adds: "The piſton leathers are ſtill as good as when the pump was firſt fixed, nor had I ever occaſion to give any part of the pump the ſmalleſt repair. I well know the great advantage of having a pump not liable to choke, having, during the voyage before yours was put on board, been nearly loſt in the Britannia, laden with corn, from the choking of the pumps. As an engine for extinguiſhing fire, as far as relates to the force,

quantity

quantity of water discharged, &c. I have given it fair trial; from which I have no hesitation in saying, that should an occasion of real danger from fire unhappily arise, it is my opinion the patent pump might be of the greatest utility."

XXXI. *Researches respecting the Laws of Affinity. By* C. BERTHOLLET, *Member of the French National Institute.*

[Continued from p. 142.]

On the Influence of the Proportions in Complex Affinities.

1. IN my researches on the laws of affinity I have ascertained the principal results presented by complex affinity, when the force of cohesion or that of elasticity is sufficiently strong to produce that change of base which has been ascribed to the superiority of the divellent affinities over the quiescent affinities. But I avoided entering into the necessary details for determining the changes which may arise from different proportions of the substances brought into action, when the force of cohesion is not sufficiently great to cause the effects of this difference to disappear. I promised (Art. XII. No 6.) to return to this subject, which I shall now proceed to do.

According to the theory explained (Art. V. No. 5.), all substances exert a mutual action while they are in the liquid state; so that in a solution, for example, of sulphate of potash and muriate of soda, these two salts are not distinct, while there is no cause to determine the separation of their combination; but there exist in this liquid sulphuric acid, muriatic acid, soda, and potash. I shall, however, continue to make use of the ordinary language, which after this notice can produce no ambiguity.

2. I begin with mixtures in which a considerable force of crystallization must determine the combinations which are formed.

Experiment A. Equal parts of nitrate of lime and sulphate of potash were mixed: after the separation of the sulphate of lime first formed, the liquid, by successive evaporations, yielded only nitrate of potash and sulphate of lime. After the last evaporation, however, some crystals of sulphate of potash were procured; there remained only a very small quantity of uncrystallizable liquid, which precipitated with carbonate of soda and with nitrate of barytes; so that it consisted of a little sulphuric acid and lime, and very probably a larger portion of nitrate of potash.

The quantity of sulphate of lime which was deposited in

the course of the evaporation was much more considerable than would have been obtained from the simple solution of this salt and water; so that its solubility was augmented by the action of the other substances.

B. Two parts of sulphate of potash and one of nitrate of lime, gave first sulphate of potash and sulphate of lime; and, by succeeding evaporations, nitrate of potash and the two sulphates, the proportions of which continued to decrease to the last crystallization. There remained only some drops of the liquid uncrystallized, which did not precipitate with carbonate of soda, but did with nitrate of barytes: hence they were probably formed of sulphate of potash and a small portion of nitrate of potash.

C. Two parts of nitrate of lime, and one of sulphate of potash, yielded, during the first evaporation, a small quantity of sulphate of lime, and, by cooling, nitrate of potash: the other evaporations only produced nitrate of potash. In the latter, however, some crystals of sulphate of lime were perceived at the surface of the liquid. The residue, which was abundant, was several times submitted to evaporation and cooling, but did not afford crystals of any salt. This uncrystallizable residue, treated with alcohol, formed an abundant deposit, which, having been dissolved in water, scarcely afforded any precipitate with nitrate of barytes. It contained, therefore, little or no sulphuric acid, and consisted of pure nitrate of potash: the portion dissolved by alcohol was nitrate of lime, with a small portion of nitrate of potash. The uncrystallizable residue was therefore composed of nitrate of potash and nitrate of lime.

In this experiment we see that the sulphate of lime was rendered much less soluble than in the preceding experiments; but that a considerable quantity of nitrate of potash lost the property of crystallizing by the action exerted on it by the nitrate of lime.

3. In these three experiments sulphate of lime must have been formed, because the lime and sulphuric acid coming in contact, would separate on account of the insolubility which belongs to their combination.

The sulphate of lime in the experiments A and B, was rendered much more soluble than it naturally is, by the action of the substances which were in solution; but in the experiment C, its solubility was not sensibly increased, probably because the nitrate of lime and the nitrate of potash, which formed the uncrystallizable liquid, mutually experienced a degree of saturation, which considerably weakened their action upon the sulphate of lime.

4. From

4. From theſe conſiderations, I ſhall proceed to deduce, firſt, the theory of the uncryſtallizable reſidues found in evaporated ſolutions of ſalts: it will be confirmed by the ſucceeding obſervations.

Saline ſubſtances exerciſe upon each other an action which increaſes their ſolubility, an effect that has been particularly eſtabliſhed by Vauquelin. (*Annales de Chimie*, tom. xiii.) This mutual action varies in the different ſalts. It has, however, been thought, that ſalts with an earthy baſe do not increaſe the ſolubility of the nitrate of potaſh, though theſe in reality increaſe it the moſt. There is in this reſpect a difference in the effect produced by the ſalts, which depends on their nature; but this difference is in general very ſmall, compared with that which proceeds from the force of cryſtallization.

D. Equal parts of nitrate of potaſh and ſulphate of potaſh afforded by evaporation, ſucceſſively, and in proportion to their ſolubility, ſulphate of potaſh and nitrate of potaſh, without leaving any uncryſtallizable liquid; but the ſame experiment being made with nitrate of ſoda and ſulphate of ſoda, both of which have only a ſlight tendency to cryſtallize, and are nearly of equal ſolubility, only a ſmall quantity of ſulphate of ſoda was ſeparated by cryſtallization; all the reſt remaining liquid, without any cryſtallization. A mixture of muriate of ſoda and ſulphate of alumine having been ſubmitted to the ſame proof, it was clearly perceived that the two ſalts had become more ſoluble; but they were entirely ſeparated by alternate evaporation and cooling. Subſtances, therefore, which poſſeſs a conſiderable force of cryſtallization, though rendered more ſoluble, ſeparate on account of their inſolubility, and leave very little or no uncryſtallizable reſiduum. But the mutual action of ſalts, which have only a feeble diſpoſition to cryſtallize, counterbalances their force of cryſtallization, ſo that there then remains much liquid which cannot cryſtallize; particularly when the reſiduum contains a ſubſtance in itſelf uncryſtallizable; as in experiment C, where, by the proportions employed, there was found a ſuperabundance of nitrate of lime, which by its action upon the nitrate of potaſh reduced a conſiderable quantity of that ſalt into an uncryſtallizable liquid. How came it, then, that the moſt learned chemiſts, Lavoiſier, Fourcroy, Vauquelin, Guiton, and the Commiſſaries of the Academy of Sciences, among whom myſelf was one, could have been led, by the experiments made upon the proof of ſaltpetre, to believe that the nitrate of lime exerts no action upon the nitrate of potaſh, nor increaſed its ſolubility? (*Annales de*

Chimie, tom. xi. xiii. xv. xxiii.) It was because, in the experiments that were made, a solution of nitrate of potash was put to digest upon dried nitrate of lime. The latter necessarily caused a division of the water, upon which it has a strong action. It would therefore have precipitated a considerable quantity of nitrate of potash, if this effect had not been compensated, or nearly so, by the solubility which it imparted to that salt; but if the solution had been evaporated, there would have been separated by crystallization much less nitrate of potash than was contained in the liquid, and an uncrystallizable residuum would have been left, similar to that of experiment C. The proof, therefore, which was considered as conclusive, induced an error respecting the chemical phænomenon. Hence it follows, that when the mother waters of the saltpetre works are decomposed by potash, the nitrate of potash obtained consists not only of that which has just been formed, but also of that which was rendered uncrystallizable by the salts with an earthy basis.

5. I made mixtures of crystallized sulphate of soda and nitrate of lime. Here the sulphate of soda, and the nitrate of soda which might proceed from the operation, differed little in point of solubility, and had a crystallizing power less considerable than the sulphate and nitrate of potash.

E. Equal parts of crystallized sulphate of soda and of dry nitrate of lime gave by evaporation only a small quantity of nitrate of soda. The uncrystallizable residue, which was abundant, did not precipitate with muriate of barytes, but did with oxalic acid.

F. Two parts of sulphate of soda, and one part of nitrate of lime, afforded, after evaporation, a greater quantity of nitrate of soda than the preceding experiment: the uncrystallizable residue did not precipitate with oxalic acid, but did with muriate of barytes. To compare the two last with the experiments A, B, and C, it must be observed that the crystallized sulphate of soda contains more than half its weight of water of crystallization. Even sulphate of soda was not formed in experiment F, as sulphate of potash was in experiments A and B, because sulphate of potash has a force of crystalliztion much greater than sulphate of soda.

The residue of experiment E did not contain a quantity of sulphuric acid perceptible by the muriate of barytes; but was formed of nitrate of soda and nitrate of lime, which probably, by their mutual action, so much exhausted their dissolvent power as not to prevent the separation of the sulphate of lime No. 3.

In experiment F the residue was not precipitated by oxalic acid,

acid, but by the muriate of barytes; ſo that this reſiduum was compoſed of ſulphate of ſoda and a greater proportion of nitrate of ſoda, which mutually prevented their cryſtallization, as in experiment D.

6. *Experiment* G. Equal parts of nitrate of potaſh and ſulphate of ſoda gave by ſucceſſive cryſtallizations, 1. Sulphate of potaſh, and ſome ſmall cryſtals of nitrate of potaſh; 2. A little ſulphate of potaſh, and a greater proportion of nitrate of potaſh; 3. Small cryſtals of nitrate of potaſh, and much nitrate of ſoda: there was an uncryſtallizable reſidue, notwithſtanding the care which had been taken to obtain the utmoſt cryſtallization: this reſidue was formed of nitrates and ſulphates; for it precipitated abundantly with the nitrate of barytes, and, after drying, it flowed on ignited charcoal. This experiment ought to be compared with experiment F.

H. One part of nitrate of potaſh, and two of ſulphate of ſoda, gave, 1. Sulphate of potaſh; 2. Sulphate of potaſh, and ſome needles of nitrate of potaſh; 3. Sulphate of potaſh in ſmall priſms, ſuſpended from a pellicle formed by nitrate of ſoda, fine cryſtals of nitrate of potaſh and nitrate of ſoda: the reſidue contained nitrates and ſulphates.

In theſe two experiments, the leaſt ſoluble ſalt of thoſe which were formed, viz. the ſulphate of potaſh, was the firſt which was cryſtallized. When the proportions had been thus changed, the action of the nitric acid on the potaſh reſumed its ſuperiority, and nitrate of potaſh was formed, though the liquid ſtill contained ſulphuric acid.

In the ſecond, the more abundant ſulphuric acid gave riſe to a greater quantity of ſulphate of potaſh; but, after the firſt cryſtallization, more nitrate of potaſh was formed, though there would have been a ſufficient quantity of ſulphuric acid to cauſe a complete change of baſe, if this exchange could have been made as has been imagined. The reſidue was formed, even in experiment G, of ſulphate of ſoda and nitrate of ſoda; and probably of a ſmall quantity of ſalt with baſe of potaſh.

7. *Experiment* I. Equal weights of nitrate of potaſh and muriate of lime were mixed together: by evaporation there were, 1. Nitrate of potaſh; 2. Muriate of potaſh, in which was found a little nitrate of potaſh: the reſidue gave with the ſulphuric acid an abundant precipitate of ſulphate of lime, and vapours of muriatic and nitric acid were diſengaged.

K. The experiment having been made with two parts of muriate of lime, and one of nitrate of potaſh, an abundant cryſtallization of muriate of potaſh was produced, with no appearance

appearance of nitrate: the residue, treated as in the preceding experiment, gave analogous results.

L. A mixture of equal parts of muriate of potash and nitrate of lime, afforded, 1. Nitrate of potash, mixed with a little muriate of potash; 2. Muriate of potash, which was mixed with a small quantity of nitrate of potash. The uncrystallizable residuum was dissolved in alcohol; there was a separation of nitrate of potash, which was fused upon ignited charcoal, but contained a little muriate of potash, as was seen by the test of the solution of silver. The sulphuric acid showed that the part dissolved by the alcohol contained muriatic acid, nitric acid, and lime.

In the above experiments, in which substances were employed whose combinations could not have a considerable force of crystallization, and differed but little among each other in this respect, it is evident that the formation of the salts obtained by crystallization depended on the proportions of the substances which mutually acted among each other. In experiment I, which might afford nitrate and muriate of potash, as these two salts differed little in their solubility, which, however, is rather the least in the latter, the nitrate of potash was obtained by the first crystallization; but as in experiment K the muriatic acid existed in a greater proportion, muriate of potash only was then obtained: one part of potash with muriatic acid, nitric acid and lime formed the residuum. The proportions employed in experiment L differed little from those of I, and the results were nearly the same. Opposite combinations, therefore, are obtained according to the proportions employed, or according to the period of crystallization; that is to say, according to the proportions of the substances which remain in action when a sufficient force of cohesion does not exist in the combinations that might be formed. But according to the opinion adopted by chemists, the entire change of base, which it is affirmed must take place, may be judged of even by a first crystallization. If, for example, nitrate of potash be first obtained from the proportions which have been employed of muriate of potash and nitrate of lime, a conclusion is made, that an exchange of base has been effected between the muriatic and nitric acids. If other proportions had been employed which would have afforded muriate of potash, as in experiment K, an opposite consequence would have been drawn. Chemists have even gone further: from the conclusion respecting the change of base, for example, between the muriatic and nitric acids, a further inference has been made, that the combinations

tions oppoſite to thoſe which afforded ſuch a change, would not be at all affected by their mixture.

8. I have examined what change might be produced in the reſults by a ſubſtance which has the property of forming triple ſalts, ſuch as magneſia.

M. Equal parts of ſulphate of potaſh and muriate of magneſia afforded, 1. Sulphate of potaſh; 2. Sulphate of potaſh, a little muriate of potaſh, and a triple ſalt, compoſed of ſulphuric acid, potaſh, and magneſia: this ſalt forms fine rhomboids, which, by expoſure to the air, do not loſe their tranſparency: its ſolubility is nearly the ſame as that of the ſulphate of potaſh: 3. Muriate of potaſh and ſulphate of magneſia. The reſiduum contained ſulphuric acid, muriatic acid, potaſh, and magneſia.

N. Two parts of muriate of magneſia, and one of ſulphate of potaſh, afforded, 1. Sulphate of potaſh; 2. Muriate of potaſh, and the triple ſalt of the preceding experiment; 3. Muriate of potaſh, and ſulphate of magneſia: the reſiduum was analogous to that of the preceding experiment.

In experiment M, ſulphate of potaſh was obtained by two cryſtallizations; but in experiment N, where the muriatic acid was in a greater proportion, it was obtained on the firſt cryſtallization; the triple ſalt, which in ſolubility nearly approaches the ſulphate of potaſh, cryſtallized after the ſecond evaporation. When the proportion of ſulphuric acid was ſufficiently diminiſhed by theſe cryſtallizations, then the muriate of potaſh was ſeparated nearly according to the order of ſolubility; and laſtly the magneſia, which being ſtill abundant, cryſtallized with part of the ſulphuric acid. We ſee that a different opinion might have been formed in theſe two experiments, according to the period of the cryſtallization at which it might have been obſerved; and how erroneous the eſtabliſhed opinion is, that a complete change of baſes takes place on the mixture of muriate of magneſia and ſulphate of potaſh.

In experiment M, where the ſulphuric acid was preſent in greater proportion, ſulphate of potaſh was obtained in both the firſt cryſtallizations; but in experiment N, where the muriatic acid had more influence by its relative quantity, ſulphate of potaſh only was obtained in the firſt cryſtallization; the magneſia, for the moſt part, remained in the uncryſtallizable reſidue, becauſe it has no force of cryſtallization with the muriatic acid, and only a weak power with the ſulphuric; other ſalts which would cryſtallize in other circumſtances, are retained in the reſidue which oppoſes their cryſtallization. The difference obſerved between the reſults of theſe two experiments, and thoſe of the experiments A, B,

and

and C, in which a deliquescent calcareous salt was put into action with the sulphate of potash, corresponds exactly with the difference of solubility which exists between the sulphate of lime and the sulphate of magnesia.

9. After having treated of saline substances in the preceding experiments, as if they formed separate or distinct combinations in a liquid, I shall now consider some effects which are owing to the mutual action which is in reality exerted by them all when they are mixed in this state.

O. An aqueous solution of acetite of lead was gradually poured into a solution of muriate of soda, till no more precipitate was produced. The liquid which remained above the precipitate strongly reddened blue paper, which effect was not produced by the mere solution of the acetite of lead, nor by the muriate of soda; but it assumed a deep colour with hydro-sulphurets, and afforded an abundant precipitate with the muriatic and sulphuric acids. During its evaporation a deposition was formed of a scarcely soluble muriate of lead, and also a crust which had not a crystalline appearance. Lastly, some fine crystals were obtained, which were an acetite of soda and an oxide of lead. On dissolving the saline crust, a deposition took place of muriate of lead with excess of oxide, analogous to that described by Vauquelin. (*Annales de Chimie*, tom. xxxi.) It was necessary to repeat the solution and crystallization several times before the deposition ceased; and the saline crust thus became divided into two substances, muriate of soda and muriate of lead.

If the muriatic acid remain engaged in the liquid together with the acetous, as both acids are volatile, the excess, which is but slightly engaged, and which may be expelled by the action of heat, must be composed of two acids. In fact, having distilled a mixture similar to the preceding, after having separated the deposition which was first formed, the liquid which passed into the receiver contained acetous and muriatic acid: this circumstance deserves particular attention, and serves to explain several phænomena.

10. C. Prieur has remarked that when lead was employed to purify a solution of silver mixed with muriatic acid, a part of the latter acid passed over by distillation. This takes place because the muriate of lead is soluble, and much so by the action of the nitric acid. The liquid is therefore composed of oxide of lead, muriatic acid and nitric acid. The oxide of lead divides its action upon the two acids, and both are subjected to the action of the expansibility produced by the heat.

If the sulphuric acid were to be retained, lead would be

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an efficacious agent: 1. Becauſe the ſulphate of lead is much leſs ſoluble than the muriate; 2. Becauſe the ſulphuric acid is much leſs volatile than the muriatic acid.

Muriate of ſilver being much more inſoluble than muriate of lead, ſilver is much better than lead for retaining the muriatic acid which happens to be in the nitric acid. Velter and Bonjour obſerved, however, that muriatic acid always came over in diſtillation, if the operation was made without the precautions indicated by thoſe learned chemiſts. To obtain a pure nitric acid immediately, it is neceſſary to make the operation upon an acid little concentrated, that it may not hold in ſolution any muriate of ſilver, and to ſeparate the muriate of ſilver which precipitates before the liquid is ſubjected to the action of heat, or, which is better, to precipitate, by a ſolution of ſilver, the muriatic acid from the nitrate of potaſh; after which, by decompoſing this nitrate, the nitric acid is obtained perfectly free from muriatic acid.

When muriate of ſilver remains in the ſolution, a very pure nitric acid may nevertheleſs be obtained by diſtillation, by ſetting aſide the firſt portion which diſtils over, till it is ſeen by the teſt that no more muriatic acid is afforded. For, as the chemiſts I have juſt quoted obſerved, the muriatic acid in this proceſs aſſumes the nature of oxygenated muriatic acid, and is diſengaged in this ſtate at the beginning of the operation.

P. Sulphate of potaſh having been treated with the acetite of lead in the ſame manner as the muriate of potaſh, ſulphate of lead was precipitated. The liquid retained only a ſmall quantity of oxide of lead. By the progreſs of evaporation ſome cryſtals of ſulphate of potaſh were obtained, though before the evaporation the acetite of lead produced no more precipitate; and, laſtly, the acetite of potaſh, which retained a ſmall quantity of oxide of lead. The decompoſition of the ſulphate of potaſh was much more complete than that of the muriate of ſoda.

In the experiments I have juſt deſcribed, we ſee, then, that the decompoſitions, or exchange of baſes, alſo follow the order of the ſolubilities of the combinations which may be formed; and that the only difference obſerved in moſt of the preceding experiments, ariſes from the property poſſeſſed by the oxide of lead of forming triple combinations, which ſometimes again ſeparate in combinations of different degrees of ſolubility, as happens with the muriate of ſoda and of lead. (Experiment O.)

11. The following experiment will confirm the truth that the

the force of cohesion produces a different effect, according to the properties of the solvent.

Q. I mixed an aqueous solution of plombate of soda with the water of sulphate of soda; a slight precipitate only was produced, though the sulphuric and muriatic acids, if added, would have produced an abundant precipitate: when the experiment was made with the muriate, the precipitate was much more abundant than with the sulphate of soda.

On the first view, these effects may appear to be contrary to the principles I have established. For the sulphate of lead is much less soluble than the muriate of lead; so that it might be expected that a more abundant precipitate would be obtained in the experiment made with sulphate of soda than with muriate of soda. This happens otherwise because sulphate of lead is much more soluble in soda, as I have ascertained, than muriate of lead with excess of oxide, such as is precipitated in the preceding experiments. And the precipitation is not a direct consequence of the force of cohesion, but arises from the excess of the force of cohesion beyond that of the solvent.

12. These observations may be reduced to the following results. In the complex affinities, or double affinities, the force of cohesion, when considerable, and differing much in its intensity among the combinations which may be formed, determines a change of bases, in such a manner, that the most insoluble combination is formed and separated independently of the proportions, which have an influence only upon the state of those substances which remain in solution. The result of a mixture of different saline substances may therefore be foretold from the mere consideration of solubility. In this case, the adopted theory of the quiescent and divellent affinities does not mislead us as to the principal result; that is to say, the formation of the insoluble salt. But, as it is not deduced from facts of a superior order, it will demand as many experiments as particular facts. The doctrine does not rest upon any foundation from which we can foretel the mutual actions of substances presented to each other; and again, it has the disadvantage of affording no indication respecting the properties which the remaining fluid portion ought to exhibit when subjected to evaporation or to the action of a new substance. Though this certain relation in the results may be productive of doubt as to the theory in the foregoing case, it is not the same when there is but a small difference between the solubility of the combinations that may be formed. The proportions of the substances, in

quantity, then, determine the formation of the different ſalts, either by a firſt cryſtallization, or by cryſtallizations which, by ſubtracting ſome of the parts, muſt alter the proportion, and occaſion a difference in the diſpoſition of the remaining principles to cryſtallize in the ſucceſſive formation of the ſalts. It is here that the application of the theory of the quieſcent and divellent affinities may produce many errors, by leading us to conclude, from the commencement of the phænomenon, that the ſubſequent effects will be all of the ſame deſcription, though in reality a ſucceſſion of oppoſite combinations may be eſtabliſhed, according to the forces which are made to act at the moment of their reſpective ſeparations. The joint conſideration of the difference of ſolubility, and of the proportions employed, or which vary at the different periods of an operation, muſt conſequently be our ſole guide in the explanation of the ſucceſſive formation of different ſalts which have no great difference in ſolubility. It is true, nevertheleſs, that the mutual action of the ſubſtances themſelves may produce ſome difference in the reſults, which would be indicated by the preceding obſervations.

All ſubſtances in a ſtate of ſolution exert a mutual action, which increaſes their ſolubility. Hence the reaſon why it is difficult to obtain, by a firſt cryſtallization, each ſalt in a ſtate of purity; except in the caſe where it differs conſiderably from the others in its force of cryſtallization. Hence ariſe the uncryſtallizable reſidues which ſucceed the cryſtallizations wherein ſalts are found in the liquid, which poſſeſs but little force of coheſion. But here alſo the conſideration of the proportions and of the ſolubility will ſerve to predict the exiſtence and compoſition of any uncryſtallizable reſiduum. While the ſubſtances are in ſolution, the action which they mutually exert renders it eaſy to expel an acid from a combination, though, according to the received opinion, it ought to aſſume the place of another, ſuppoſed to be weaker. Inſolubility muſt not be conſidered as an abſolute property, but merely as relative to the liquid in which a precipitation is made. Thus a combination inſoluble in water, may loſe this property when the water holds alkali in ſolution.

In all theſe experiments, and in ſeveral others which I have thought it uſeleſs to deſcribe, I perceived no change of ſaturation, either after the mixture of the neutral ſalts, or after the ſeparation of the precipitates or cryſtallizations which took place, except in the experiments P, Q, made with a metallic ſubſtance. This permanent ſtate of neutralization, after the change of baſes which took place, ſeems to indicate

indicate that the acids have conſtant relations of quantity, in the neutral ſalts they form, with different alkaline or earthy baſes. So that, if the ſulphuric acid, for example, exiſt in greater proportion in the ſulphate of potaſh than in the ſulphate of lime, the muriatic acid, with which it may make an exchange of baſe, will be found in the ſame ratio of quantity in the muriate of lime and in the muriate of potaſh; a concluſion that would not agree with the proportions which chemiſts have often attributed to the component parts of the different non-metallic ſalts. Guyton has already made ſeveral very juſt and important reflections on this ſubject, and quotes the obſervations of Richter, with whoſe work I am not yet acquainted. (*Annales de Chimie*, tom. xxv. p. 292.)

[To be continued.]

XXXII. *A Treatiſe on the Cultivation of the Vine, and the Method of making Wines.*

[Continued from p. 151.]

On the Clarification of Wines.

2d, BESIDES the operation of ſulphuring wines, there is another, no leſs eſſential, called *clarification*. It conſiſts, in the firſt place, in drawing off the wine from the lees, which requires certain precautions, and in then diſengaging it from all the principles ſuſpended or weakly diſſolved in it; ſo that nothing may be retained but the ſpiritous and incorruptible principles alone. Theſe operations are even performed before that of ſulphuring, which is only a continuation of them.

The firſt of theſe operations is called drawing off, tranſvaſation, defecation. According to Ariſtotle, this operation ought to be often repeated: *quoniam ſuperveniente æſtatis calore ſolent fæces ſubverti, ac ita vina aceſcere.*

In the different wine countries there are certain fixed periods of the year for this operation, eſtabliſhed, no doubt, on the conſtant and reſpectable obſervation of ages. At the Hermitage, the wine is drawn off in March and September; in Champagne, on the 13th of October, about the 15th of February, and towards the end of March.

Dry, cold weather is always choſen for this operation. It is certain that it is then only that the wine is in a good condition. Damp weather, and ſoutherly winds, always render

wine turbid; and care muſt be taken not to draw it off while theſe prevail.

Baccius has left us ſome excellent precepts reſpecting the moſt favourable periods for the defecation of wine. He adviſes the weakeſt wines, that is to ſay, thoſe produced from fat covered ſoil, to be drawn off at the winter ſolſtice; moderate wines, in the ſpring; and the moſt generous, during ſummer. He gives as a general precept, not to draw off wine but when the north wind prevails; and he adds, that wine drawn off at the time of full moon is converted into vinegar!

The manner of drawing off wine can be a matter of indifference only to thoſe unacquainted with the effect of atmoſpheric air on that liquid: by opening the tap, or placing a cock at about four inches from the bottom of the caſk, the wine which runs off becomes aërated, and determines movements in the lees; ſo that, under this double view, the wine acquires a diſpoſition to become ſour. A part of theſe inconveniences has been obviated by drawing off the wine by means of a ſyphon; the motion is then gentler, and by theſe means one may penetrate to any depth at pleaſure, without agitating the lees. But all theſe methods are attended with faults, which have been completely remedied by the help of a pump, the uſe of which has been eſtabliſhed in Champagne and other wine countries.

To a leather pipe, of from four to ſix feet in length, and two inches in diameter, are adapted at each end wooden pipes, nine or ten inches in length, which decreaſe in diameter towards the ends, and are fixed to the leather pipe by means of a piece of packthread. The bung of the caſk intended to be filled is taken out, and one of the extremities of the pipe is put into it. A good cock is fixed in the caſk to be emptied two or three inches from the bottom, and into this is inſerted the other extremity of the pipe.

By this mechaniſm alone, the half of the one caſk is emptied into the other: for this purpoſe nothing is neceſſary but to open the cock; and the remainder may be made to paſs by a very ſimple proceſs, for which a pair of bellows about two feet in length, comprehending the handles, and ten inches in breadth, are employed. The bellows force the air through a hole formed at the anterior part of the ſmall end: a ſmall leather valve, placed below the ſmall hole, prevents the air from ruſhing out when the bellows are opened, and to the extremity of the bellows is adapted a perpendicular wooden pipe to convey the air downwards: this tube is fitted into the bunghole in ſuch a manner, that when the bellows

are worked, and the air forced out, a preſſure is exerciſed on the wine, by which means it is obliged to iſſue from the one caſk, and to aſcend into the other. When a hiſſing is heard at the cock, it is ſpeedily ſhut: this is a ſign that all the wine has paſſed.

Funnels of tin plate, the tubes of which are at leaſt a foot and a half in length, that they may be immerſed in the liquor without cauſing any agitation, are alſo employed.

Drawing off wine ſeparates a part of its impurities, and conſequently removes ſome of thoſe cauſes which may alter the quality of it; but there ſtill remain ſome ſuſpended in the liquor, which cannot be caught but by the following operations, which are called *fining* of wine, or *clarification:* Fiſh-glue (iſinglaſs) is almoſt always employed for this purpoſe: it is unrolled with care, and cut into ſmall morſels, and it is then ſteeped in a little wine, where it ſwells up, becomes ſoft, and forms a viſcid maſs, which is poured into the wine. The wine is then ſtrongly agitated, after which it is left at reſt. Some whip the wine, in which the glue has been diſſolved, with a few twigs of birch, &c. and by theſe means occaſion a conſiderable foam, which is carefully removed. In all caſes a portion of the glue is precipitated with the principles it has enveloped, and the liquor is drawn off when the depoſit is formed.

In warm climates the uſe of glue is dreaded, and during ſummer its place is ſupplied by whites of eggs: ten or twelve are ſufficient for half a *muid**. The eggs are firſt beat up with a little wine; they are then mixed with the liquor intended to be clarified, and it is whipped with the ſame care. It is poſſible that gum arabic might be ſubſtituted for glue. Two ounces will be ſufficient for four hundred pots of wine. It is put into the liquor in the form of a fine powder, and the liquor is then ſtirred.

Wine muſt not be drawn off till it is completely made: if the wine is green and harſh, it muſt be ſuffered to ferment a ſecond time on the lees, and muſt not be drawn off till towards the middle of May; if it continues green, it may even be left till the end of June. It even ſometimes happens that it is neceſſary to convey back the wine to the lees, and to mix them ſtrongly, that the wine may again acquire that movement of fermentation which is neceſſary to bring it to perfection.

We are told by Miller that when Spaniſh wine becomes turbid by the lees, it may be clarified by the following proceſs: Put the whites of eggs, gray ſalt, and ſalt water, into a

* About a 72 gallon caſk Engliſh.

convenient

convenient veſſel; ſkim off the foam formed at the ſurface, and pour the compoſition into the wine caſk from which a part of the liquor has been drawn off: at the end of two or three days the liquor becomes clear, and acquires an agreeable taſte. After being ſuffered to remain at reſt for about a week, it is then drawn off.

To revive claret injured by floating lees, two pounds of calcined flints, well pounded, ten or twelve eggs, and a large handful of ſalt, are beat up with two gallons of wine, which are then poured into the caſk: two or three days after, the wine is drawn off.

Theſe compoſitions may be varied without end: ſometimes ſtarch is employed, and alſo rice, milk, and other ſubſtances, more or leſs capable of developing the principles which render the wine turbid.

Wine is clarified alſo, and its bad taſte is often corrected, by making it digeſt over ſhavings of beech wood, previouſly ſtripped of the bark, boiled in water, and dried in the ſun or in a ſtove: a quarter of a buſhel of theſe ſhavings will be ſufficient for a *muid* of wine. They produce a ſlight movement of fermentation in the liquor, which becomes clear in the courſe of twenty-four hours.

The art of *cutting wines* (couper du vin), as it is called, (correcting one wine by another—giving a body to thoſe wines which are weak—colour to thoſe deſtitute of it—and an agreeable flavour to thoſe which have none, or which have a bad one,) cannot be deſcribed. In theſe caſes, the taſte, ſight, and ſmell muſt be conſulted. The highly variable nature of the ſubſtances employed muſt be ſtudied; and it will be ſufficient for us to obſerve, that in this part of the management of wines every thing conſiſts: 1ſt, In ſweetening wines, and rendering them ſaccharine by the addition of *baked muſt*, concentrated with honey, ſugar, or another wine of a very luſcious quality. 2d, Colouring the wine by an infuſion of turnſole cakes, the juice of elder-berries, logwood, and mixing it with dark, and, generally, coarſe wine. 3d, Perfuming it by ſyrup of raſpberries, an infuſion of the flowers of the vine ſuſpended in the caſk, tied up in a bag, as is practiſed in Egypt, according to the teſtimony of Haſſelquiſt.

In the Orleanois, and other countries, a wine is made called there *vin rapé*. It is prepared from picked grapes, which are trod with wine or ley; placing in the preſs a ſtratum of vine-twigs and another of grapes in alternate order, or by infuſing the twigs in the wine. Theſe wines are made to boil ſtrongly, and they are then employed to give ſtrength

and colour to the weak colourleſs wines of the cold and damp countries.

Though wine may work at all times, there are certain periods of the year at which fermentation ſeems to be renewed in a particular manner; and, above all, when the vine begins to bud, when it is in flower, or when the grapes begin to become coloured. At theſe critical moments, wine ought to be watched with particular care; and every movement of fermentation may be prevented by drawing off, and ſulphuring it, as aboye indicated.

When wines are completely clarified, they are preſerved in caſks, or in glaſs. The largeſt veſſels are the beſt, and they ought to be well cloſed. Every body has heard of the enormous capacity of the tun of Heidelberg, in which wine is preſerved for whole centuries, always improving in quality; and it is allowed that wine keeps better in very large caſks than in ſmall ones.

The choice of ſituation in which veſſels containing wine ought to be depoſited, is not a matter of indifference: on this ſubject we find among the antients uſages and precepts which deviate for the moſt part from our common methods, but which, in part, are worthy of attention. The Romans drew off the wine from the caſks to ſhut it up in large earthen veſſels glazed in the inſide: this is what they called *diffuſio vinorum*. It appears that for containing wines they had two ſorts of veſſels, which they called *amphora* and *cadus*. The *amphora* was of a ſquare or cubical form, had two handles, and contained twenty gallons of liquor. This veſſel terminated in a narrow neck, which was ſtopped with pitch or plaſter to prevent the wine from exhaling. This we learn from Petronius, who ſays, *Amphoræ vitreæ diligenter gypſatæ allatæ ſunt, quarum in cervicibus pittacia erant affixa cum hoc titulo*—"*Falernum opimanum annorum centum.*" The *cadus* had the figure of the cone of a fir-tree; it contained one-half more than the *amphora*.

The moſt generous wines were expoſed to the open air in veſſels well cloſed; the weakeſt were prudently placed under cover: *Fortius vinum ſub dio locandum, tenuia vero ſub tecto reponenda, cavendaque a commotione ac ſtrepitu viarum*, ſays Baccius. Galen obſerves that the whole wine was put into bottles, after which it was expoſed to a ſtrong heat in cloſe apartments; and in ſummer it was expoſed to the ſun on the tops of the houſes, that it might ſooner become mellow, and fit for drinking. *Omne vinum in lagenas transfundi, poſtea in clauſa cubicula multâ ſubjecta flammâ reponi, et in tecta ædium æſtate inſolari, unde citius maturescant ac potui idonea evadant.*

That

That wine may keep, and improve in quality, it ought to be put into veſſels depoſited in proper places, the choice of which is not a matter of indifference. Glaſs veſſels are the moſt favourable, becauſe, beſides their preſenting no principle ſoluble in wine, they ſhelter it from the contact of the air, from moiſture, and the principal variations of the atmoſphere. Care muſt be taken to ſhut theſe veſſels very cloſely with good cork; and to lay the bottles on their ſides, that the cork may not dry, and facilitate the acceſs of the air. For the greater ſafety, the cork may be covered with a coating of wax, applied by means of a bruſh; or the neck of the bottle may be immerſed in a mixture of melted wax, reſin, and pitch. Some people cover the wine with a ſtratum of oil: this proceſs is recommended by Baccius. The neck is then covered with an inverted glaſs tumbler, a veſſel of tin plate, or any matter capable of preventing inſects or mice from falling into the wine.

The veſſels moſt generally employed for keeping wine are caſks, which for the moſt part are made of oak. They vary in ſize, and are known by different names, ſuch as pipes, hogſheads, &c. The great inconvenience of caſks is, that they not only preſent to the wine ſubſtances which are ſoluble in it, but that they are affected by the variations of the atmoſphere, and afford a paſſage both to the air which endeavours to eſcape from them, and to that of the atmoſphere which penetrates them.

Glazed earthen veſſels have the advantage of retaining a more equal temperature; but they are more or leſs porous, and at length the wine in them muſt become dry. In the ruins of Herculaneum veſſels were found in which the wine had dried. Rozier ſpeaks of a ſimilar urn diſcovered in a vineyard in the territory of Vienne in Dauphiny, in a place where the palace of Ponipey had formerly ſtood. The Romans remedied the poroſity of earthen veſſels by covering them with wax on the inſide, and pitch on the outſide: they covered alſo the whole ſurface with wax cloths, which they applied with great care.

Pliny condemns this uſe of wax, becauſe, he ſays, it made the wine turn ſour: *Nam ceram accipientibus vis, compertum eſt vina aceſcere.*

Whatever may be the nature of the veſſels deſtined to contain wine, a cellar ſheltered from all accidents muſt be choſen.

1ſt, The expoſure of the cellar muſt be northern: its temperature is then leſs variable than when the apertures are turned towards the ſouth.

2d, It muſt be of ſuch a depth that the temperature may be

conſtantly the ſame. *In cellis quæ non ſatis profundæ ſunt diurni caloris participes fiunt; vina non diu ſubſiſtunt integra,* ſays Hoffman.

3d, The moiſture in it muſt be conſtant, without being too great: exceſs of moiſture renders the papers, corks, caſks, &c. mouldy. Dryneſs deſiccates the caſks, and makes them leak.

4th, The light ought to be very moderate: a ſtrong light dries; darkneſs, almoſt abſolute, rots.

5th, The cellar muſt be ſheltered from ſhocks. Violent agitation, or that ſhaking occaſioned by the rapid paſſage of carriages along the ſtreet, agitates the lees, mixes them with the wine, where they are kept ſuſpended, and occaſions acetification. Thunder, and all movement occaſioned by ſhocks, produce the ſame effect.

6th, Green wood, vinegar, and all ſubſtances ſuſceptible of fermentation, muſt be kept at a diſtance from a cellar.

7th, The reverberation of the ſun, which, as it neceſſarily changes the temperature of a cellar, muſt alſo alter the properties of the wine preſerved in it, ought alſo to be guarded againſt.

A cellar, therefore, muſt be dug to the depth of ſome fathoms below ground; its apertures ought to be directed towards the north; it muſt be at a diſtance from the ſtreet, highways, workſhops, ſewers, neceſſaries, &c. and ought to be arched at the top.

VII. Maladies of Wine, and the Means of preventing or correcting them.

There are ſome wines which improve by age, and which cannot be conſidered as perfect till a long time after they have been made. Luſcious wines are of this kind, as well as all highly ſpiritous wines; but delicate wines are ſo apt to turn *ſour*, or *oily*, that it is only by means of great precaution they can be preſerved for ſeveral years.

The firſt of the principal kinds of wine known in Burgundy, is that of Volney, near Beaune. This wine, ſo delicate and agreeable, will not bear the vat above 12, 16, or 18 hours, and can ſcarcely be kept from one vintage to another.

The ſecond of the principal kinds of wine in Burgundy is that of Pomard: it keeps better than the former; but if kept longer than a year, it becomes oily, ſpoils, and aſſumes the colour of the peelings of onions.

In every canton the wine has a fixed and known period of duration; and it is every where known that this period muſt be ſhorter or longer according to the nature of the ſeaſon, and the care employed in the proceſs of vinification. No one is ignorant

ignorant that the wine made from grapes collected in rainy weather, or produced in fat soil, is not of long duration.

The antients, as we are informed by Galen and Athenæus, had determined the epoch of age, or the period at which the different wines ought to be drunk:—Falernum *ab annis decem ut potui idoneum, et a quindecim usque ad viginti annos:* after that period *grave est capiti et nervos offendit.* Albani *vero cum duæ sint species, hoc dulce illud acerbum, ambo a decimo quinto anno vigent.* Surrentinum *vigesimo quinto anno incipit esse utile, quia est pingue et vix digeritur, at veterascens solum sit potui idoneum.* Tiburtinum *leve est, facile vaporat, viget ab annis decem.* Lubicanum *pingue et inter albanum et falernum putatur usui ab annis decem idoneum.* Gauranum *rarum invenitur, at optimum est et robustum.* Signinum *ab annis sex potui utile.*

The care employed in drawing off wine, and mixing it with *mute* wine, contributes greatly to its preservation. Few kinds are shipped without this precaution. It is of importance then, for the prevention of all its alterations, that all these operations should be multiplied and repeated; and it is to this valuable practice we are indebted for the power of being able to send wine to all climates, and to subject it to all temperatures, without fear of decomposition.

Among the diseases to which wines are most subject, *oiliness* and *acidity* are the most common and most dangerous.

Oiliness is an alteration which wines often contract: they lose their natural fluidity, and become ropy, like oil.

The less spiritous wines turn oily; and weak wines, which have fermented very little, are the most disposed to this malady. Weak wines, made from grapes which have been picked, are also subject to it.

Wine turns oily in the best corked bottles. Of this there are too frequent instances in Champagne, where the wine of a whole vintage, when put into glass vessels, is exposed sometimes to this alteration.

Oily wines furnish by distillation but a little fat coloured and oily spirit.

This fault may be corrected several ways.

1st, By exposing the bottles to the air, and, above all, in a well-aired barn.

2d, By shaking the bottle for a quarter of an hour; then uncorking it, and suffering the gas and foam to escape.

3d, By mixing the wine with fish-glue and whites of eggs mixed together.

4th, By introducing into each bottle one or two drops of lemon juice, or any other acid.

From the nature of the cauſes which produce oilineſs in wines, the phænomena exhibited by that malady, and the means employed to cure it, it is evident that this alteration ariſes from the extractive principle, which has not been ſufficiently decompoſed.

We find a ſimilar effect in beer, in the decoction of gall-nuts, and in ſeveral other caſes where the extractive matter, being very abundant, is precipitated from the liquor which held it in ſolution; and acquires the characters of fibrine matter, unleſs burned by a fermentation or precipitated by an acid.

Aceſcence of wine is however the moſt common malady, and, we may even ſay, the moſt natural, for it is almoſt a conſequence of ſpiritous fermentation; but by knowing the cauſes which produce it, and the phænomena which accompany or announce it, means may be taken to prevent it. The antients admitted three principal cauſes of the acidity of wines:—1ſt, The humidity of the wine: 2d, The inconſtancy or variations of the atmoſphere: 3d, Commotions.

To know this malady exactly, we muſt call to mind ſome principles which can alone furniſh us with light on this ſubject.

1ſt, Wine never turns ſour until the ſpiritous fermentation is terminated; or, in other words, till the ſaccharine principle is completely decompoſed. Hence the advantage of putting wine into caſks before all the ſaccharine principle has diſappeared; becauſe the ſpiritous fermentation then continues, is prolonged, and removes every thing that can pave the way for acetous decompoſition. Hence the practice of putting a little ſugar into the bottle to preſerve the wine without alteration; and hence the very general method of baking a part of the muſt at a ſlow and moderate heat, and of mixing ſome of it in the caſks intended for embarkation. In ſome places of Spain and Italy all the muſt is baked; and Bellon ſays that the wines of Crete would not keep at ſea unleſs the precaution were taken to boil them.

2d, The leaſt ſpiritous wines are thoſe which ſooneſt become ſour. We know, by experience, that when the ſeaſon is rainy, if the grapes be little ſaccharine, which conſequently give little alcohol, the wines readily turn ſour. The weak wines of the north become ſour with great eaſe; while the ſtrong, generous, ſpiritous wines obſtinately reſiſt acidity.

It is however no leſs true, that the moſt ſpiritous wines furniſh the ſtrongeſt vinegar, though their acetification is more difficult, becauſe alcohol is neceſſary to the formation of vinegar.

3d, Wine

3d, Wine perfectly free from all extractive matter, either in conſequence of its being depoſited naturally by time or by clarification, is not ſuſceptible of turning ſour. I have expoſed old wine in uncorked bottles to the ardour of the ſun of July and Auguſt for more than forty days without the wine loſing its quality; only the colouring principle was conſtantly precipitated under the form of a membrane, which covered the bottom of the bottle. The ſame wine in which I infuſed vine-leaves, became ſour in a few days. It is known that old wines, well purified, do not turn ſour.

4th, Wine does not acidify, or become ſour, but when in contact with the air: atmoſpheric air mixed with wine is a real leaven of acidity. When wine grows flat (*ſe pouſſe*) it ſuffers to eſcape, or exhales, the gas it contains, and the external air then enters to aſſume its place. Rozier propoſes to adapt a bladder to a pipe inſerted in the veſſel, in order to aſcertain the abſorption of the air and the diſengagement of the gas. When the bladder fills, the wine tends to flatten; if it empties itſelf, it is a ſign of its turning ſour.

When wine flattens, the caſk ſuffers the wine to ooze through the ſides, and if a hole be made with a gimblet, the wine eſcapes with a hiſſing noiſe and foam: on the other hand, when wine turns ſour, the ſides of the caſk, the bung, and the luting, are dry, and the air ruſhes in with violence as ſoon as it is unſtopped.

From this circumſtance it may be concluded that wine ſhut up in very cloſe veſſels is not ſuſceptible of becoming ſour.

5th, There are certain times of the year when the wine turns more readily ſour. Theſe periods are, the moment when the ſap riſes in the vine, when it flowers, or when the grapes aſſume a reddiſh tint. It is during theſe periods, in particular, that precautions muſt be taken to prevent its becoming acid.

6th, Change in the temperature alſo promotes acidity, eſpecially when the heat riſes to 80 or 90 degrees. The degeneration is then rapid, and almoſt unavoidable.

The acidity of wine may be eaſily prevented by removing all thoſe cauſes before mentioned which tend to produce this alteration; and when it has begun, it may be remedied by the means, more or leſs effectual, which we are going to mention.

Baked muſt, honey, or liquorice, are diſſolved in wine in which acidity has manifeſted itſelf: by theſe means its ſour taſte is corrected, being concealed by the ſweetiſh ſavour of theſe ingredients.

The

The little acid which has been formed may be ſeized by the means of aſhes, alkalies, chalk, lime, and even litharge. This laſt ſubſtance, which forms a very ſweet ſalt with acetous acid, is exceedingly dangerous. This criminal adulteration may be eaſily detected by pouring hydro-ſulphuret of potaſh (liver of ſulphur) into the wine. There will be immediately formed an abundant and black precipitate. Sulphurated hydrogen gas may alſo be made to paſs through this altered liquor: this will produce a blackiſh precipitate, which is nothing but ſulphuret of lead.

The works of oinologiſts abound with recipes, of greater or leſs value, for correcting the acidity of wine.

Bidet ſays, that about a fiftieth of ſkimmed milk added to ſour wine reſtores it; and that it may be drawn off in five days.

Others take four ounces of the beſt wheat, boil it in water till it burſts; and, when it has cooled, put it into a ſmall bag which is immerſed in the caſk, ſhaking it with a ſtick.

Some recommend alſo the ſeeds of leeks, fennel, &c.

To ſhow the futility of the greater part of theſe remedies, it will be ſufficient to obſerve, that it is impoſſible to make fermentation proceed in a retrograde manner, and that it can at moſt be ſuſpended; that the whole of the acid then formed may be ſeized, or its exiſtence may be concealed, by ſweet and ſaccharine principles.

But beſides theſe alterations there are others, which, though leſs common and dangerous deſerve to be noticed. Wine ſometimes contracts what is called a taſte of the caſk. This malady may ariſe from two cauſes: firſt, when the wine is put into caſks, the wood of which is rotten or damaged; ſecondly, when lees have been left to dry in the caſks into which new wine is put. Willermoz propoſes lime water, carbonic acid, and oxygenated muriatic acid, to correct the bad taſte ariſing from the caſk: others recommend mixing the wine with iſinglaſs, drawing it carefully off, and infuſing roaſted wheat in it for two or three days.

A phænomenon, which has ſtruck and embarraſſed the numerous authors who have ſpoken of the diſeaſes of wine, is what is called the *flowers of wine*. Theſe are formed in caſks, but particularly in bottles, in which they occupy the neck; they conſtantly announce and precede the acid degeneration of wine. They manifeſt themſelves in almoſt all fermented liquors, and always more or leſs abundantly according to the quantity of extractive matter exiſting in the liquor. I have ſeen them formed in ſuch abundance, in a fermented mixture of molaſſes and the yeaſt of beer, that they

they precipitated themſelves in the liquor in pellicles, or numerous and ſucceſſive ſtrata. In this manner, I have obtained twenty ſtrata.

Theſe flowers, which I at firſt took for a precipitate of tartar, is, in my opinion, a vegetation, or real *byſſus*, which belongs to that fermented ſubſtance. It is reduced almoſt to nothing by deſiccation, and by analyſis exhibits only a little hydrogen and a great deal of carbon.

All theſe rudiments or commencements of vegetation, which develop themſelves in all caſes where an organic matter is decompoſed, ought not, in my opinion, to be claſſed with perfect plants: they are not ſuſceptible of reproduction, and are only a ſymmetric arrangement of the moleculæ of the matter, which ſeems rather directed by the ſimple laws of affinity than thoſe of life. Similar phænomena are obſerved in all decompoſitions of organic beings.

In the years 1791 and 1792, the whole product of the vintage was altered at the commencement by an acrid, nauſeous odour, which went off after a long-continued fermentation. This effect was owing to an enormous quantity of tree-bugs, (*punaiſes de bois*,) which had ſettled on the grapes, and which had been cruſhed in treading them.

VIII. Uſes and Virtues of Wine.

Wine has become the moſt uſual beverage of man, and is, at the ſame time, the moſt varied. Wine is known in all climates; and the attraction of this liquor is ſo ſtrong, that the prohibitory law reſpecting it, which Mahomet impoſed on his followers, is daily broken.

This liquor, beſides being a tonic and ſtrengthener, is alſo more or leſs nutritive: in every point of view, it muſt be ſalutary. The antients aſcribed to it the property of ſtrengthening the underſtanding. Plato, Æſchylus, and Solomon, all agree in aſcribing to it this virtue. But no writer has better deſcribed the real properties of wine than the celebrated Galen, who aſſigns to each ſort its peculiar uſes, and deſcribes the difference they acquire by age, climate, &c.

Exceſs in regard to the uſe of wine has at all times called forth the cenſure of legiſlators. It was cuſtomary among the Greeks to prevent intoxication by rubbing their temples and forehead with precious ointments and tonics. The anecdote of that famous legiſlator, who, to reſtrain the intemperance of the people, authorized it by an expreſs law, is well known; and we read that Lycurgus cauſed drunken people to be publicly exhibited, in order to excite a horror of intoxication in the

Lacedæmonian youth. By a law of Carthage, the uſe of wine was prohibited in the time of war. Plato interdicted it to young perſons below the age of twenty-two. Ariſtotle did the ſame to children and nurſes. And we are informed by Palmarius that the laws of Rome allowed to prieſts, or thoſe employed in the ſacrifices, but three ſmall glaſſes of wine at their repaſts.

But, notwithſtanding the wiſdom of laws, the hideous picture of intemperance, and the fatal conſequences with which it is attended, the attractions of wine have been ſo powerful among certain nations, that their fondneſs for it has degenerated into a paſſion and real want. We daily ſee men, prudent in other reſpects, gradually acquire the habit of indulging immoderately in the uſe of this liquor; and in their wine extinguiſh their moral faculties and their phyſical ſtrength.

Narratur et priſci Catonis,
Sæpe mero incaluiſſe virtus.

We learn from hiſtory, that Wenceſlas, king of Bohemia and of the Romans, having come to France to negotiate a treaty with Charles VI. repaired to Rheims in the month of May 1397, where he got intoxicated every day with the wine of the country, chooſing rather to forego every thing than not indulge in this exceſs *.

The virtue of wine differs according to its age. New wine is flatulent, indigeſtible, and purgative: *muſtum flatuoſum et concoctu difficile. Unum in ſe bonum continet, quod alvum emolliat. Vinum rarum infrigidat;—muſtum craſſi ſucci eſt, et frigidi.*

The antients confounded theſe words—*muſtum et novum vinum.* Ovid ſays, *Qui nova muſta bibant. Unde virgo muſta dicta eſt pro intacta et novella.*

Light wines only can be drunk before they have grown old. The reaſon we have mentioned in the preceding pages. The Romans, as we have obſerved, followed this cuſtom, and drank their wines in ſucceſſion: *Vinum Gauranum et Albanum, et quæ in Sabinis et in Tuſcis naſcuntur, et Amienum quod circa Neapolim vicinis collibus gignitur.*

New wines are not at all nouriſhing, eſpecially thoſe which are aqueous, and little ſaccharine: *corpori alimentum ſubgerunt pauciſſimum,* ſays Galen.

Theſe wines readily produce intoxication; and the reaſon of this is, the quantity of carbonic acid with which they are charged. This acid, by diſengaging itſelf from the liquor

* Obſervations ſur l'Agriculture, vol. ii. p. 192.

by

by the temperature of the ſtomach, extinguiſhes the irritability of the organs, and brings on ſtupor.

Old wines, in general, are tonic, and very wholeſome: they are ſuited to weak ſtomachs, old people, and in all caſes where ſtrengthening is neceſſary: they afford very little nouriſhment, becauſe they are deprived of their really nouriſhing principles, and contain ſcarcely any other than alcohol.

It is of ſuch wine that the poet ſpeaks, when he ſays:

> ——————— Generoſum et lene requiro
> Quod curas abigat, quod cum ſpe divite manet
> In venas animumque meum, quod verba miniſtret,
> Quod me, Lucane, juvenem commendet amicæ.

Oily thick wines are the moſt nouriſhing. *Pinguia ſanguinem augent et nutriunt*;—Galen. The ſame author recommends the wines of Therea and Scibellia as highly nouriſhing: *quod craſſum utrumque, nigrum et dulce.*

Wines differ alſo eſſentially in regard to colour. Red, in general, is more ſpiritous, lighter, and more digeſtible: white wine furniſhes leſs alcohol, and is more diuretic and weaker, as it has remained leſs time in the vat: it is almoſt always more oily, more nutritive, and more gaſeous, than the red.

Pliny admits four ſhades in the colour of wines—*album, fulvum, ſanguineum, rubrum:* but it would be too minute as well as uſeleſs to multiply ſhades, which might become infinite, by extending them from black to white.

Climate, culture, and variety in the proceſſes of fermentation, produce alſo infinite differences in the qualities and virtues of wine. To avoid fatiguing repetitions, we muſt refer to what we have already ſaid on this ſubject.

The art of tempering wine by the addition of one part of water was practiſed among the antients: wine of this kind they called *vinum dilutum.* Pliny, after Homer, ſpeaks of a wine which could bear twenty parts of water. The ſame hiſtorian informs us, that in his time wines ſo ſpiritous were known, that they could not be drunk: *niſi pervincerentur aqua et attenuentur aqua calida.*

The antients, who had very juſt and correct ideas reſpecting the art of making and preſerving wines, ſeem to have been unacquainted with that of diſtilling ſpirit from them: the firſt correct ideas reſpecting the diſtillation of wine are aſcribed to Arnaud de Villeneuve, profeſſor of medicine at Montpellier.

The diſtillation of wines has given a new value to this production. It has not only furniſhed a new beverage,

ſtronger

ſtronger and incorruptible, but has made known to the arts the real ſolvent of reſins and of aromatic principles, and, at the ſame time, a mean as ſimple as certain for preſerving animal and vegetable ſubſtances from all putrid decompoſition. It is on theſe remarkable properties that the art of the varniſher, the perfumer, the maker of liqueurs, and others founded on the ſame baſis, have been ſucceſſively eſtabliſhed.

XXXIII. *Deſcription of the Table and the Paarlberg Mountains, in Southern Africa. By* JOHN BARROW, *Eſq.**

THE firſt appearance of ſo ſtupendous a maſs of naked rock as the Table Mountain, cannot fail to arreſt, for a time, the attention of the moſt indifferent obſerver of nature from all inferior objects, and moſt particularly intereſt that of the mineralogiſt. As a deſcription of this mountain will, with few variations, anſwer to that of almoſt all the great ranges in Southern Africa, it may not, perhaps, be thought too tedious to enter into a detail of its form, dimenſions, and conſtituent parts.

The name of *table land* is given by ſeamen to every hill or mountain whoſe ſummit preſents to the eye of the obſerver a line parallel to the horizon. The north front of the Table Mountain, directly facing the town, is a horizontal line, or very nearly ſo, of about two miles in length. The bold face, that riſes almoſt at right angles to meet this line, is ſupported, as it were, by a number of projecting buttreſſes that riſe out of the plain, and fall in with the front a little higher than midway from the baſe. Theſe and the diviſion of the front, by two great chaſms, into three parts, a curtain flanked by two baſtions, the firſt retiring and the others projecting, give to it the appearance of the ruined walls of ſome gigantic fortreſs. Theſe walls riſe above the level of Table Bay to the height of 3582 feet, as determined by captain Bridges, of the royal engineers, from a meaſured baſe and angles taken with a good theodolite. The eaſt ſide, which runs off at right angles to the front, is ſtill bolder, and has one point higher by ſeveral feet. The weſt ſide, along the ſea ſhore, is rent into deep chaſms, and worn away into a number of pointed maſſes. In advancing to the ſouthward about four miles, the mountain deſcends in ſteps or terraces, the loweſt of which communicates by gorges with the chain

* From *Barrow's Travels into Southern Africa*, a work highly worthy of the attention of every perſon fond of natural hiſtory.

that

that extends the whole length of the peninsula. The two wings of the front, one of the Devil's Mountain, and the other the Lion's Head, make, in fact, with the Table, but one mountain. The depredations of time and the force of torrents, having carried away the looser and less compact parts, have disunited their summits, but they are still joined at a very considerable elevation above the common base. The height of the first is 3315, and of the latter 2160 feet. The Devil's Mountain is broken into irregular points; but the upper part of the Lion's Head is a solid mass of stone, rounded and fashioned like a work of art, and resembling very much, from some points of view, the dome of Saint Paul's placed upon a high cone-shaped hill. These three mountains are composed of a multitude of rocky strata, piled on each other in large tabular masses. Their exact horizontal position denotes the origin of the mass to be neptunian, and not volcanic; and that, since its first formation, no convulsion of the earth has happened in this part of Africa sufficient to have disturbed the nice arrangement of its parts. The strata of these postdiluvian ruins not being placed in the order of their specific gravity, might lead to the conclusion that they were deposited in successive periods of time, were it not for the circumstance of their lying close upon each other, without any intermediate veins of earthy or other extraneous materials. The stratification of the cape peninsula, and, indeed, of the whole colony, is arranged in the following order:

The shores of Table Bay, and the substratum of the plain on which the town is built, compose a bed of a blue compact schistus, generally placed in parallel ridges in the direction of north-west and south-east, but frequently interrupted by large masses of a hard flinty rock of the same colour, belonging to that class of aggregated stones proposed by Mr. Kirwan to be called *granitelles*. Fine blue flags, with whitish streaks, are procured from Robben Island, in the mouth of Table Bay, which are used for steps, and for paving the terraces in front of most of the houses.

Upon the schistus lies a body of strong clay coloured with iron from a pale yellow to deep red, and abounding with brown foliated mica. Imbedded in the clay are immense blocks of granite, so loosely cemented together, that the constituent parts are easily separated by the hand. The mica, the sand, and indeed the whole bed of clay, seem to have been formed from the decomposition of the granite. Between the Lion's Head and the sea, are vast masses of these aggregated stones entirely exposed. Most of them are rent, and falling asunder from their own weight; others are com

pletely

pletely hollowed out, ſo as to be nothing more than a cruſt or ſhell; and they have almoſt invariably a ſmall aperture on that ſide of the ſtone which faces the bottom of the hill or the ſea ſhore. Such excavated blocks of coarſe granite are very common on the hills of Africa, and are frequently inhabited by runaway ſlaves.

Reſting on the granite and clay is the firſt horizontal ſtratum of the Table Mountain, commencing at about five hundred feet above the level of the ſea. It is ſiliceous ſand-ſtone of a dirty yellow colour. Above this is a deep brown ſand-ſtone, containing calciform ores of iron, and veins of hematite, running through the ſolid rock. Upon this reſts a maſs, of about a thouſand feet in height, of a whitiſh-gray ſhining granular quartz, mouldering away in many places by expoſure to the weather, and in others paſſing into ſand-ſtone. The ſummit of the mountain has entirely undergone the tranſition into ſand-ſtone; and the ſkeletons of the rocks, that have hitherto reſiſted the ravages of time, are ſurrounded by myriads of oval-ſhaped and rounded pebbles of ſemi-tranſparent quartz that were once imbedded in them. Thoſe pebbles, having acquired their rounded form by friction, when the matrix, in which they are ſtill found buried, had not aſſumed the form and conſiſtence of ſtone; and the ſituation of this ſtratified matrix on blocks of primæval granite, clearly point out a grand revolution to have taken place on the ſurface of the globe we inhabit. No organized remains, however, of the old world, ſuch as ſhells buried in the rock, petrifactions of fiſhes, or impreſſions of plants, appear on the ſides of the Table Mountain, as has been aſſerted.

To thoſe whom mere curioſity, or the more laudable deſire of acquiring information, may tempt to make a viſit to the ſummit of the Table Mountain, the beſt and readieſt acceſs will be found directly up the face next to the town. The aſcent lies through a deep chaſm, that divides the curtain from the left baſtion. The length of this ravine is about three-fourths of a mile, the perpendicular cheeks at the foot more than a thouſand feet high, and the angle of aſcent about forty-five degrees. The entrance into this deep chaſm is grand and awful. The two ſides, diſtant at the lower part about eighty yards from each other, converge within a few feet at the portal, which opens upon the ſummit, forming two lines of natural perſpective. On paſſing this portal, a plain of very conſiderable extent ſpreads out, exhibiting a dreary waſte and an inſipid tameneſs, after quitting the bold and romantic ſcenery of the chaſm. And the adventurer may perhaps feel ſtrongly diſpoſed to aſk himſelf, if ſuch be all

the gratification he is to receive for having undergone ſo great a fatigue in the aſcent. The mind, however, will ſoon be relieved at the recollection of the great command given by the elevation; and the eye, leaving the immediate ſcenery, will wander with delight round the whole circumference of the horizon. On approaching the verge of the mountain—

> " How fearful
> And dizzy 'tis to caſt one's eyes ſo low!
> The fiſhermen that walk upon the beach
> Appear like mice; and yon tall anchoring bark
> Diminiſhed to her cock. - - - - -
> - - - - - - - - The murmuring ſurge,
> That on the unnumbered idle pebbles chafes,
> Cannot be heard ſo high."

All the objects on the plain below are, in fact, dwindled away to the eye of the ſpectator into littleneſs and inſignificance. The flat-rooſed houſes of Cape Town, diſpoſed into formal clumps, appear like thoſe paper fabrics which children are accuſtomed to make with cards. The ſhrubbery on the ſandy iſthmus looks like dots; and the farms and their incloſures as ſo many lines, and the more finiſhed parts of a plan drawn on paper.

On the ſwampy parts of the flat ſummit, between the maſſes of rock, are growing ſeveral ſorts of handſome ſhrubs. The *cenæa mucronata*, a tall, elegant, fruteſcent plant, is peculiar to this ſituation; as is alſo that ſpecies of heath called the *phyſodes*, which, with its cluſters of white flowers, glazed with a glutinous coating, exhibits in the ſunſhine a very beautiful appearance. Many other heaths, common alſo on the plains, ſeemed to thrive equally well on this elevated ſituation as in a milder temperature. The air on the ſummit, in the clear weather of winter, and in the ſhade, is generally about fifteen degrees of Fahrenheit's ſcale lower than in Cape Town*. In the ſummer ſeaſon the difference is much greater, when that well known appearance of the fleecy cloud, not inaptly called the *tablecloth*, envelops the ſummit of the mountain.

A ſingle glance at the topography of the Cape and the adjacent country, will be ſufficient to explain the cauſe of this phænomenon, which has ſo much the appearance of ſingularity. The mountainous peninſula is connected with a ſtill more mountainous continent, on which the great ranges run parallel to, and at no great diſtance from, the ſea

* The general ſtandard of the three winter months at Cape Town may be reckoned at 50° at ſunriſe to 60° at noon. In the middle of ſummer it varies from 70° to 90°, but reſts for days together at 83° or 84°.

coaſt. In the heat of the ſummer ſeaſon, when the ſouth-eaſt monſoon blows ſtrong at ſea, the water taken up by evaporation is borne in the air to the continental mountains, where, being condenſed, it reſts on their ſummits in the form of a thick cloud. This cloud, and a low denſe bank of fog on the ſea, are the precurſors of a ſimilar but lighter fleece on the Table Mountain, and of a ſtrong gale of wind in Cape Town from the ſouth-eaſt. Theſe effects may be thus accounted for:—The condenſed air on the ſummit of the mountains of the continent, ruſhes, by its ſuperior gravity, towards the more rarefied atmoſphere over the iſthmus, and the vapour it contains is there taken up and held inviſible, or in tranſparent ſolution. From hence it is carried by the ſouth-eaſt wind towards the Table and its neighbouring mountains, where, by condenſation from decreaſed temperature and concuſſion, the air is no longer capable of holding the vapour with which it was loaded, but is obliged to let it go. The atmoſphere on the ſummit of the mountain becomes turbid, the cloud is ſhortly formed, and, hurried by the wind over the verge of the precipice in large fleecy volumes, rolls down the ſteep ſides towards the plain, threatening momentarily to deluge the town. No ſooner, however, does it arrive, in its deſcent, at the point of temperature equal to that of the atmoſphere in which it has floated over the iſthmus, than it is once more taken up, and "vaniſhes into air—to thin air." Every other part of the hemiſphere ſhows a clear blue ſky, undiſturbed by a ſingle vapour.

The Paarlberg, on the left of the paſs into the valley, is a hill of moderate height, and has taken its name from a chain of large round ſtones that paſs over the ſummit like the pearls of a necklace. Of theſe, the two that are placed near the central and higheſt point of the range are called, *par excellence*, the Pearl and the Diamond; and a particular deſcription of them has been thought worthy of a place in the Philoſophical Tranſactions. From that paper, and Mr. Maſſon's deſcription, it would appear that theſe two maſſes of ſtone reſted upon their own baſes, and were detached from the mountain; whereas they grow out, and form a part of it. It has alſo been ſaid that their compoſition was totally different from the rocks that are found in the neighbouring mountain, which led a naturaliſt in Europe to obſerve, that theſe immenſe blocks of granite had probably been thrown up by volcanic exploſions, or by ſome cauſe of a ſimilar nature. It has been obſerved in the preceding pages, that the ſand-ſtone ſtrata of the Table Mountain reſted upon a bed of primæval granite, and that an infinite number of large ſtones

were

were ſcattered at the feet of the mountains along the ſea coaſt, from the Lion's Head to the true Cape of Good Hope. All theſe are preciſely of the ſame nature and the ſame materials as the Pearl and the Diamond; that is to ſay, they are aggregates of quartz and mica; the firſt in large irregular maſſes, and the latter in black lumps reſembling ſhorl: they contain alſo cubic pieces of feltſpar, and ſeem to be bound together by plates of a clayey iron-ſtone. All the ſtones of this deſcription appear to have been formed round a nucleus, as by the action of the air and weather they fall to pieces in large concentric laminæ. The Pearl is acceſſible on the northern ſide, but is nearly perpendicular on all the reſt. This ſloping ſide is more than a thouſand feet, and the perpendicular altitude about four hundred feet, above the ſummit of the mountain; and the circumference of its baſe is a full mile. Near the top it is quadriſected by two clifts, croſſing at right angles, in which were growing a number of beautiful aloes, ſeveral cryptogamous and other plants. A great part of the ſlanting ſide was covered with a ſpecies of green lichen. Down the perpendicular ſides were immenſe rifts, as if the maſs had been torn aſunder by its own weight. The Diamond is the higher block, but leſs bulky, and, being cone-ſhaped, is difficult and dangerous to aſcend.

XXXIV. *Obſervations on the Means of enabling a Cottager to keep a Cow by the Produce of a ſmall Portion of Arable Land.* *By Sir* JOHN SINCLAIR, *Bart. M. P.**

IN ſeveral parts of the kingdom, as in Lincolnſhire, Rutlandſhire, &c., which are calculated for grazing, it is not unuſual to give induſtrious cottagers as much land as will enable them to keep a cow, and ſometimes two, or more, beſides other ſtock; and it appears from the communications of Lord Winchelſea and others to the Board of Agriculture, from the publications of the Society for bettering the Condition of the Poor, and from a late intereſting work printed by Mr. Arthur Young †, that ſuch a ſyſtem is productive of the happieſt conſequences. It is ſuppoſed, however, to be totally inapplicable to an arable diſtrict. I truſt that ſuch an opinion will not be admitted without full conſideration.

* Drawn up for the conſideration of the Board of Agriculture and Internal Improvement.

† Intitled "An Inquiry into the Propriety of applying Waſtes to the better Maintenance and Support of the Poor."

Indeed, ſo far as I can judge, this advantageous ſyſtem is to the full as well adapted for the one diſtrict as for the other. It requires unqueſtionably more labour on the part of the cottager, and of his family; at the ſame time, the occupation of ſo great an extent of ground is not ſo neceſſary in arable as in grazing countries; a circumſtance, in various reſpects, extremely material.

In arranging the following plan, (which the reader will pleaſe to conſider merely as furniſhing an outline, to be perfected by further diſcuſſion and experiment,) it is propoſed to keep in view the following principles:

1. That the cottager ſhall raiſe, by his own labour, ſome of the moſt material articles of ſubſiſtence for himſelf and his family.

2. That he ſhall be enabled to ſupply the adjoining markets with the ſmaller agricultural productions. And,

3. That both he and his family ſhall have it in their power to aſſiſt the neighbouring farmers, at all ſeaſons of the year, almoſt equally as well as if they had no land in their occupation.

It can hardly be queſtioned, that if it were practicable to have a number of cottagers of that deſcription in every pariſh, it would promote, in various reſpects, the intereſts of the public.

I. Extent of Land neceſſary.

Unleſs the experiment were fairly tried, it is impoſſible to ſtate exactly the extent of arable land requiſite to enable a cottager to raiſe the articles generally neceſſary for the ſuſtenance of himſelf and family; and to keep a cow, ſome pigs, and poultry. Much muſt depend on the natural richneſs of the ſoil; (though, under the management about to be propoſed, almoſt any ſoil would, in time, become fertile;) on the nature of the climate; on the ſize of the cow; on the induſtry of the cottager; on the age and number of his family, &c. But I ſhould imagine that three ſtatute acres and a quarter of good arable land, worth from 20*s.* to 30*s.* per acre, would be ſufficient. It is propoſed that the three acres ſhall be under a regular courſe of cropping. The quarter of an acre ought, if poſſible, to be converted into an orchard; where the cow might occaſionally paſture, and where a pond ought to be kept in good order, that it may have plenty of water at command. Were the land of a quality fit for lucerne, perhaps two acres and a quarter might be ſufficient.

II. Stock and Inſtruments of Huſbandry.

It is evident that ſo ſmall an extent of land as either two or three acres, under cultivation, excludes all idea of ploughing *; and, indeed, unleſs the cottager ſhall manage the whole in the ſimpleſt and cheapeſt manner, there is an end to the whole ſyſtem. It would require, indeed, four or five acres to keep a ſingle horſe, and the expenſe of purchaſing horſes, or even oxen, ploughs, and other inſtruments of huſbandry, muſt be far beyond the abilities of a cottager; whereas with a ſpade, a hoe, a rake, a ſcythe, a ſickle, and a flail, which are all the inſtruments really neceſſary, he is perfectly competent to the management of his little farm.

III. Courſe of Crops, &c.

The three acres propoſed to be cultivated ſhould be divided into four portions, each conſiſting of three roods, under the following ſyſtem of management:

	Roods.
Under potatoes two roods, under turnips one †	3
Under winter tares two roods, ſpring tares one	3
Under barley, wheat, or oats - -	3
Under clover, with a mixture of rye graſs ‡	3
Total	12 Roods.

Other articles beſides theſe might be mentioned, but it ſeems to me of peculiar importance to reſtrict the attention of the cottager to as few objects of cultivation as poſſible.

It is propoſed that the produce of the two roods of potatoes ſhall go to the maintenance of the cottager and his family §; and that the rood of turnips ſhould be given to the cow in winter and during the ſpring, in addition to its other fare.

The ſecond portion, ſown with tares, (the two roods of potatoes of the former year to be ſucceſſively ſown with winter tares, and the turnip rood with ſpring tares,) might partly be cut green, for feeding the cow in ſummer and autumn; but, if the ſeaſon will permit, the whole ought to be

* Ploughs might, perhaps, be hired; but, on the whole, the ſpade culture is infinitely preferable, and I would much rather ſee a cottager hire perſons to trench than to plough for him.

† I would alſo recommend a ſmall quantity of flax, where the culture and management of the plant was known, to employ the females, particularly in winter, and to ſupply the family with linen.

‡ Some recommend the proportion per acre to be at the rate of one buſhel of rye graſs to 12 lbs. of red clover; others, 14 lbs. of red clover to half a buſhel of rye graſs.

§ By Sir John Methuen Poore's experiments it was found that half a rood, or one-eighth of an acre, produced, for ſeveral years, as great a weight of potatoes as was ſufficient for a family of four perſons. Four acres anſwered for 131 perſons.

made into hay for the winter and ſpring feed, and three roods of clover cut green for ſummer food.

The third portion may be ſown either with barley, wheat, or oats, according to the ſoil or climate, and the general cuſtom of the country. The ſtraw of any of theſe crops would be of eſſential ſervice for littering the cow, but would be ſtill more uſeful, if cut into chaff, for feeding it.

The fourth portion, appropriated to clover and rye graſs, to be cut green, which, with the aſſiſtance of the orchard, will produce, on three roods of land, as much food as will maintain a cow and her calf for five months, namely, from the end of May, or beginning of June, when it may be firſt cut, to the firſt of November, beſides ſome food for the pigs. It is ſuppoſed that an acre of clover and rye graſs, cut green, will produce 20,000 lbs. weight of food for cattle. Three roods, therefore, ought to yield 15,000 lbs. weight. A large cow requires 110 lbs. weight of green food per day; a middling ſized cow, ſuch as a cottager is likely to purchaſe, not above 90 lbs.; conſequently, in five months, allowing 1320 lbs. weight for the calf and the pigs, there will remain 13,680 lbs. for the cow *. Were there, however, even a ſmall deficiency, it would be more than compenſated by the rood of land propoſed to be kept in perpetual paſture as an orchard.

IV. Mode in which the Family may be maintained.

It is calculated that three roods and eight perches of potatoes will maintain a family of ſix perſons for about nine months in the year; but, according to the preceding plan, it is propoſed to have but two roods under that article; for however valuable potatoes are juſtly accounted, yet ſome change of food would be acceptable, and the cottager will be enabled, from the produce of the cow, and by the income derived from his own labour, and from that of his family, to purchaſe other wholeſome articles of proviſion.

V. Manner in which the Stock may be kept.

It appears from the preceding ſyſtem of cropping, that ten roods of land, or two acres and a half, are appropriated to the raiſing of food for the cow in ſummer and winter, beſides the paſture of the orchard; and unleſs the ſeaſon ſhould be extremely unfavourable, the produce will be found not only adequate to that purpoſe, but alſo to maintain the calf for ſome time, till it can be ſold to advantage. It is indeed extremely material, under the propoſed ſyſtem, to make as

* Theſe calculations are merely given as data for experiment. It muſt depend upon the ſeaſon, whether the tares or the clover ſhould be made into hay.

much

much profit of the calves as poſſible, as the money thus raiſed will be a reſource, enabling the cottager to replace his cow when a new one muſt be purchaſed.

For the winter proviſion of the cow, which is the moſt material, becauſe ſummer food can be more eaſily procured, there is the produce,

1. Of about three roods of tares made into hay.

2. Of three roods of ſtraw, deducting what may be neceſſary for litter; and if dry earth be put in the cow's hovel, and removed from time to time to the dunghill, little or no litter will be neceſſary.

3. Of one rood of turnips.

The whole will be ſufficient for ſeven months in the year, namely, from the 1ſt November to the 1ſt June; and during the remaining five months, the paſture of the orchard, ſome of the winter tares, and the produce of three roods of clover and rye graſs, will not only ſuffice, but will furniſh a ſurplus for the calf, if it is kept for any length of time *, and ſome clover for the pigs.

The inferior barley, potatoes, &c. will of courſe be given to the pigs and the poultry.

VI. Value of the Produce.

The land thus managed will certainly produce, by means of the extra induſtry of the family, and at a ſmall expenſe, a moſt important addition to the income which the cottager may derive from his ordinary labour. For inſtance:

	per Ann.
1. The orchard (after the trees become fruitful) will probably yield - -	£. 1 10 0
2. Three roods of turnips and potatoes -	4 0 0
3. Eighteen buſhels of barley, at 4*s.* -	3 12 0
4. The cow and calf † - - -	7 0 0
5. Hogs - - - -	3 0 0
6. Poultry and eggs - - -	2 0 0
Total	£. 21 2 0

Where

* In a pamphlet juſt publiſhed by Richardſon, Cornhill, on the Culture of Potatoes, price 1*s.* the following mode of applying the refuſe potatoes to the feeding of calves is ſtrongly recommended:

"Take two gallons of ſmall potatoes, waſh them clean, put them into a pot of boiling water ſufficient to cover them, and let them boil till the whole becomes a pulp: then add more water, and run the whole through a hair ſieve, which will produce a ſtrong nutritive gruel. At firſt uſe a very ſmall quantity, warmed up with milk, to make it palatable to the calf, and increaſe the quantity daily, till it becomes equal. A quart of potatoe gruel, and a quart of ſcald or ſkimmed milk, will be ſufficient for a good meal, which ſhould be given warm three times a day."

† According to Mr. Kent's calculations, a cow ſhould produce ſix quarts

Where wheat can be raiſed inſtead of barley, the profit would be ſtill more conſiderable. Opinions will differ much regarding the value put on each article; but that is of little conſequence, as the total cannot be accounted too high.

VII. Time required for cultivating the Land.

The quantity of land intended to be cultivated, will not materially interfere with the uſual labour of the cottager. It will only require to be dug once, and is then fit to be cropped. It is propoſed that only nine roods ſhall be annually cultivated, (the remaining three roods being under clover and rye graſs,) and nine roods may be dug in the ſpace of about 558 hours, or at the rate of 62 hours per rood. This might be done at bye hours, (more eſpecially when the family of the cottager ſhall be ſomewhat advanced, and conſequently more able to furniſh aſſiſtance); but ſuppoſing that the digging, manuring, harveſting, &c. will require twenty entire days per annum in addition to the bye hours, and allowing ſixty days for Sundays and holidays, there will remain 285 days for the ordinary hand labour of the cottager, which, at 1*s.* 6*d.* per day, would amount to £.21 7*s.* 6*d.*; the earnings of the wife and children may, at an average, be worth at leaſt £.4 per annum more. This is certainly a low calculation, conſidering how much may be got during the hay and corn harveſts; but even at that moderate eſtimate, the total income of the family will be as follows:

1. Produce of the farm - -	£.21	2	0
2. Labour of the cottager - -	21	7	6
3. Earnings of the family - -	4	0	0
Total	£.46	9	6

VIII. Buildings.

It is impoſſible to calculate the expenſe of building a cottage, as ſo much depends upon its ſize, the place where it is ſituated, the materials of which it is compoſed, the price of labour in the country, and a variety of other circumſtances. On this important ſubject, much uſeful information is contained in the firſt volume of the Communications publiſhed by the Board of Agriculture. But it is proper to obſerve that no expenſive additional buildings will be neceſſary, in conſequence of the propoſed ſyſtem. A ſhed or hovel for the cow cannot occaſion any very heavy charge, and a ſmall

of milk per day, worth 1*d.* per quart, equal to 3*s.* 6*d.* a week, or £.9 2*s.* per annum, ſetting the profit of the calf againſt the loſs ſuſtained when the cow is dry: but it is better to be rather under than over the mark.

barn,

barn, of the simplest and cheapest construction, may be of use, not only for threshing the crop, but also for securing the hay, and making it to more advantage, in case the season should prove unfavourable: if the corn is put up in small stacks, the barn may be made of very moderate dimensions.

IX. Rent, and Balance of Income.

The rents of cottages and of land vary so much in different parts of the kingdom, that it is difficult to ascertain an average. But if the cottage shall be stated at £.3 per annum, the land at 25*s.* per acre, and the orchard at 10*s.* the whole will not exceed £.7 15*s.* The cottager will also be liable to the payment of some taxes, say to the amount of £.1 5*s.* more. Hence the total deductions would be about £.9, leaving a balance in favour of the cottager of £.37 9*s.* 6*d.* Considering the cheap rate at which he is furnished with a quantity of potatoes, equal to several months consumption, and with milk for his children, surely, with that balance, he can find no difficulty not only in maintaining himself and family in a style of comfort, but also in placing out his children properly, and laying up a small annual surplus, that will render any parish assistance, whether in sickness or old age, unnecessary; and thus he will be enabled to preserve that manly and independent spirit which it so well becomes a British cottager to possess *.

CONCLUSION.

Advantages of the proposed System.

I shall now endeavour briefly to explain some of the advantages, which may be looked for with confidence from the proposed system.

In the first place, the land possessed by the cottager would be completely cultivated, and rendered as productive as possible. The dung produced by the cow, the pigs, &c. would be amply sufficient for the three roods under turnips and potatoes; which would afterwards produce, 1. Tares, 2. Barley, and 3. Clover; with a mixture of rye grass, in regular succession, without any additional manure. The barley should yield at least eighteen bushels, besides three bushels for seed; and if wheat or oats are cultivated, in the same proportion. The milk, deducting what may be necessary for the calf, and for the cottager's family, might be sold in its original state, if there shall be a market for it, or converted into butter,

* The different expense of fuel in the various districts will, it is evident, greatly affect the annual surplus.

for

for the purpoſe of ſupplying the neighbouring towns or villages. Such cottagers, alſo, might certainly ſend to market both eggs and poultry.

2. It is hardly poſſible to ſuggeſt a meaſure more likely to promote the benefit of a numerous and valuable body of people. The ſyſtem of keeping cows by cottagers, which has been found ſo advantageous in the grazing diſtricts, may thus be extended over the whole kingdom; and, indeed, if the above plan is found to anſwer, in place of four or five acres employed in feeding a ſingle cow, it would be much better, even in the grazing counties, to reſtrict the land to a ſmaller quantity, under a tillage mode of management; for thus not only the cow, but alſo the cottager himſelf, and his family, would, in a great meaſure, be maintained by a leſs ſurface of ſoil.

3. It is of infinite conſequence to eſtabliſh the practicability of this ſyſtem, as the means of removing a moſt unfortunate obſtacle to the improvement of the country. It is well known to be the only popular objection to the incloſure of our waſtes and commons, that, while unincloſed, a number of cottagers are enabled to keep cows by the means of their common rights, and that their cows diſappear when the commons are incloſed. But if ſo ſmall a portion of land as $3\frac{1}{4}$ acres, when improved and properly cultivated, can enable a cottager to keep a cow even to more advantage than with a right of common; which can hardly be doubted, as he is enabled to provide winter as well as ſummer food, there is an end to that obſtacle to improvement. Indeed, if ſufficient attention be paid to the principles above detailed, the ſituation of the cottager, inſtead of being deteriorated, would be materially bettered by the incloſure; and his riſing family would be early accuſtomed to habits of induſtry, inſtead of idleneſs and vice.

I ſhall conclude with aſking, if any one can figure to himſelf a more delightful ſpectacle than to ſee an induſtrious cottager, his buſy wife, and healthy family, living in a comfortable houſe, rented by himſelf, cultivating their little territory with their own hands, and enjoying the profits ariſing from their own labour and induſtry; or whether it is poſſible for a generous landholder to employ his property with more ſatisfaction, or in a manner more likely to promote, not only his own, but the public intereſt, than in endeavouring to increaſe the number of ſuch cottagers, and encouraging, by every means in his power, the exertions of ſo meritorious and ſo important a claſs of the community.

London, May 1801. JOHN SINCLAIR.

Plan

Plan of the proposed Cottage Farm, pointing out the Rotation of Crops in the different Lots.

Cottage.	The Orchard, or perpetual Pasture.	Pond.

Lot A.	Lot B.
3 Roods.	3 Roods.
1. Year { 2 Roods Potatoes, 1 Rood Turnips	1. Year { 2 Roods Winter Tares, 1 Rood Spring Tares

Lot C.	Lot D.
3 Roods.	3 Roods.
1. Year—Barley, Wheat, or Oats.	1. Year—Clover and Rye-grass.

The Rotation of Crops for Four Years.

Year.	Lot A.	Lot B.	Lot C.	Lot D.
1	Potatoes and Turnips	Winter and Spring Tares	Barley, Wheat, or Oats	Clover and Rye-grass
2	Winter and Spring Tares	Barley, Wheat, or Oats	Clover and Rye-grass	Potatoes and Turnips
3	Barley, Wheat, or Oats	Clover and Rye-grass	Potatoes and Turnips	Winter and Spring Tares
4	Clover and Rye-grass	Potatoes and Turnips	Winter and Spring Tares	Barley, Wheat, or Oats

The rotation then begins as at first. Lot D might continue in natural grass the first season, to diminish the labour of that year.

The exact period when the different crops should be dug for, or sown, cannot be ascertained, because it varies so much in different counties, and depends upon the seasons; but, according to the above rotation, the labour of digging for the various crops is diversified as much as possible, so as not to interfere materially with the other occupations of the cottager. At no period would it be necessary for him to dig more than two roods in a month; and both he and his family will labour with much more satisfaction and dispatch when they work for themselves than for another. In case of necessity, the cottager might hire some of his neighbours to assist him in digging, which would be much better than hiring a plough. If a cottager under this system could not work as a common daily labourer, he might, at least, answer as a useful labourer by the piece.

XXXV. *Letter from Sir* HENRY VAVASOUR, *Bart. to the Right Hon. Lord* CARRINGTON, *P. B. A. on Field Gardening Huſbandry.*

THIS communication, publiſhed by the Board of Agriculture as an appendix to Sir John Sinclair's Obſervations, (ſee the preceding article,) ſtrongly confirms the practicability of a cottager being enabled to keep a cow by the produce of arable land only.

"My Lord, London, May 20, 1801.

"I have had the honour of mentioning in converſation, to your lordſhip, the advantages that appeared to me in cultivating land in the Flemiſh manner, or what is now called, about Fulham and that neighbourhood, the *field-gardening* huſbandry. I have for ſome years encouraged my cottagers in Yorkſhire in this mode of managing their ſmall garths or gardens, which are in general from one to three acres; and I have now an opportunity of ſtating the huſbandry of a poor induſtrious cottager's garth. As the man can neither read nor write, theſe particulars have been tranſmitted to me from his own mouth; and, as I ſaw his land almoſt every day during the laſt harveſt, I can vouch that this account is not far from the truth.

Produce.	Value.	A. R. P.
240 Buſhels of potatoes - -	£. 24 0 0	0 2 0
60 Ditto of carrots - -	6 0 0	0 1 0
5 Quarter of oats, at 44*s.* per quarter	11 0 0	0 3 20
4 Load of clover, part in hay, part cut green	12 0 0	1 0 10
Turnips - - -	1 0 0	0 0 20
In garden-ſtuff for the family, viz. beans, peas, cabbages, leeks, &c. -	0 0 0	0 0 30
	£. 54 0 0*	3 0 0

Deduct rent	£. 9	0	0	including the houſe.
Seeds, &c.	3	0	0	
Value of labour	10	10	0	
	£. 23	2	0	

Produce before ſtated. £. 54 0 0

23 2 0

Profit £. 30 18 0 if ſold at market, excluſive of butter.

"His ſtock was two cows and two pigs: one of his cows had a ſummer's gait for twenty weeks with his landlord. The land was partly ploughed and partly dug with the ſpade, cultivated (the ploughing excepted) by the man, his wife, and a girl about twelve years of age, in their *ſpare* hours from their daily *hired* work, ſeldom a whole day off, except

* Theſe ſums are conformable to the prices of this year, but it is evident that in other ſeaſons they muſt in general be lower.

in

in harveſt; made the rent in butter, beſides a little uſed in the family. The man relates that he thinks he clears, one year with another, from the three acres, about £.30. The daily wages his family earns, about keep them. It is very evident that this man clears from his three acres more than a farmer can poſſibly lay by from more than eighty acres of land in the common huſbandry of the country, paying for horſes, ſervants, &c.; and it muſt be obvious to every one how great the advantages muſt be to ſociety by cultivating land in this manner. It would have taken more than half the quantity of his three acres in paſture for one cow at graſs during half the year; whereas (excepting the ſummer's gait for one of his cows, as mentioned before) his ſtock of two cows and two pigs is kept and carried on the whole year. The family lives well, and a handſome ſum has been yearly ſaved to place out two ſons, and ſupply them with clothes, waſhing, &c.

"I am, &c. HENRY VAVASOUR.

"P. S. The man's name is Thomas Rook."

XXXVI. *Conjectures reſpecting the Origin of the American Nations.*

[Concluded from p. 129.]

6. *Arrows the Symbol of a general Proclamation.*

THESE arrows, which were blunt, were not feathered, and had a greater reſemblance to ſmall ſticks than to arrows. They were employed at firſt for foretelling future events. The names of the objects reſpecting which information was required were written upon two of them, and a third remained without writing; one arrow contained the things good or bad which had been obſerved, and another forbade them. All the three were put into a covered veſſel, and on drawing one of them out, the perſon who conſulted this kind of oracle knew what to do. If the thing was allowed, the perſon proſecuted his purpoſe; if it was forbidden, he purſued meaſures of a different kind: but if the arrow without writing was drawn out, it was believed that the proper period for engaging in the undertaking had not yet arrived. Theſe arrows, however, are not the kind here alluded to, but thoſe by which the aſſembling of a whole people was forbidden. They were much uſed, in particular, in the northern kingdoms. "When an army comes into the land," ſay the Norwegian laws, "or when any inſurrection takes place in the country, a meſ-

ſage ſtick ſhall be cut and ſent through it." In Sweden, orders for ſummoning the magiſtrates to adminiſter juſtice, as well as every other meſſage, in the time of peace as well as war, were iſſued in the like manner. According to all appearance the art of writing was then unknown, and therefore ſuch ſticks were employed inſtead of circular letters. The ſame cuſtom has been obſerved among the Moguls in Siberia, among the Oſtiaks and the Tartars. Barlæus ſays, that the American ſavages of Chili, when they intended to make war on the Spaniards, ſent an arrow, with a ſtring faſtened to it, to their neighbouring allies. If the chief received the arrow, it was a ſign that he was reſolved to ſupport the war; he made a knot on the ſtring, and ſent the arrow to the next. The other chiefs did the ſame, and the meſſenger returned with his arrow, having the ſtring full of knots. Le Gentil, who made a voyage round the round, ſays that the knots are of different colours, which not only denote the plan, but the place and day on which it is to be carried into execution. Don Antonio de Ulloa, however, ſays nothing of the knots being of different colours, but in other reſpects he coincides with the abovementioned writers.

7. *Tattooing on the Face and whole Body.*

Figures cut out in the ſkin of the human body were, according to the teſtimony of Herodotus, tokens of a noble birth. Ammianus Marcellinus ſays that the Huns cut out figures on the cheeks of their new-born male children, with a view, as he ſuppoſes, of preventing the growth of the beard. This, however, does not appear to have been the real cauſe; for the Huns, like their neighbours the Chineſe, had from nature very little beard, and only a few ſtraggling hairs on the cheeks and chin. We are informed by Claudian that the Picts, formerly a people of Great Britain, and the Geloni, a people of Greek extraction who inhabited on the Dnieper, made figures on their limbs with an iron inſtrument. This practice is very common in Siberia among the Tunguſians, as we are expreſsly told by Gmelin the elder, in the account of his travels. In the ſmall iſland of Meangis, not far from Mindanao, the men as well as the women cut out figures on their ſkin according to a certain pattern; they then put into the wounds finely pulverized gum, and afterwards rub over them a certain ſalve. Captain Dampier, who examined a Miangi prince, ſpeaks highly of this kind of painting, and ſays that it is exceedingly beautiful, and that the flowers, leaves, &c. are ſo ingeniouſly executed, that they beſpeak no ſmall degree of art.

We are told by Lady Mary Wortley Montague, that the women in the neighbourhood of Tunis ornament their neck, face, arms, and ſhoulders, with flowers, ſtars, and figures of all kinds, which are burnt in with gunpowder; and that this is conſidered as a mark of extraordinary beauty. The women on the river Gambia, when young, form, on their neck, breaſt, and arms, with a hot needle, figures of all kinds, which have the appearance of flowers worked on ſilk, and which never are obliterated. In the kingdom of Widah, young maids are prepared for the ſervice of the great ſnake, which is their principal Fetiſh, or deity, by ſcratching out various figures, particularly of ſnakes, on their ſkin with an iron inſtrument, by which means their ſkin has the appearance of fine figured ſatin. This is a ſign that ſuch perſons are devoted to the great ſerpent.

The ſavages of the iſthmus of Darien, in America, form figures on their bodies in like manner. They make an outline of the figure they intend to paint, ſays Wafer, and prick it with a thorn till the blood guſhes out; they then beſmear the place with the colour moſt agreeable to them, and the figures cannot afterwards be effaced. This cuſtom was very prevalent in many countries of America, ſuch as Florida, Virginia, Louiſiana, and Canada, and even in the cold climate of Greenland. The women, accecording to Anderſon, ſew, with a thread which they have drawn through the ſoot of their lamps, between the eyes, on the cheeks, chin, and ears, all kinds of ſmall characters between the ſkin and the fleſh, the black marks of which, when the wounds have healed up, conſtantly remain, and have a reſemblance to the well-known figures which thoſe who viſit the holy ſepulchre cauſe to be formed on their arms.

8. *Scalping Priſoners, or Enemies who have been killed in Battle.*

This operation was performed in the following manner: The ſkin, being cut on the forehead, was torn off backwards to the ears and the hind part of the head. The ſkin, after a certain preparation, was made to aſſume a round form, then ſtuck upon the end of a pole, and carried about in triumph. A paſſage in Herodotus relating to this ſubject has been improperly tranſlated by Gronovius, for it alludes to the ſcalp taken from an enemy killed in battle. The Scythians freed it from the fleſh adhering to it by means of the rib-bone of an ox, and then gave it the ſame preparation as their leather in order to render it durable. A remarkable paſſage on this ſubject, alſo, occurs in Oroſius. Speaking of the Cimbric

and

and Teutonic women, he ſays they defended themſelves courageouſly againſt the Romans till the ſkin of their head was pulled over their ears, in which ſtate they were left to their fate. It may naturally be aſked where the Romans acquired this barbarous practice, of which no other inſtance is to be found in antient hiſtory. I am therefore inclined to think that the Cimbri had firſt treated the Roman priſoners in the ſame manner, and that the Romans, out of revenge, copied their example. The Cimbri may have inherited this practice from the Scythians their anceſtors. We are told by Ammianus Marcellinus that the Alani, who lived beyond the Palus Mæotis, ſtripped the ſkin from the heads of their vanquiſhed enemies, and ſuſpended it from their horſes as an honourable trophy of victory.

In North America this barbarous practice is exceedingly common, eſpecially among the ſavages of Canada. The moſt remarkable circumſtance here is, that ſome of thoſe who are ſcalped ſurvive the operation. Laſiteau aſſerts, that, during the courſe of his miſſion, he ſaw the wife of a Frenchman in Canada who was cured after the operation, and continued in good health.

9. *Putting to Death old and infirm Perſons.*

Herodotus ſpeaks of an Indian nation, whom he calls the Pagæi, who put to death and ate their old and infirm people, both male and female. The firſt inhabitants of Sardinia had a law, in virtue of which children were obliged to kill their parents when they had paſſed the age of 70. Hartknoch ſpeaks of a like practice among the antient Pruſſians. It is well known, in regard to the northern nations, that old people, who had become uſeleſs on account of their great age, precipitated themſelves, partly with their own conſent and partly by compulſion, from a mountain into the ſea. As long as a Hottentot is fit for labour, he is ſure of life; but when he becomes old, and incapable of performing the uſual occupations, a hut is built for him in a diſtant place, where he is left, and where he either dies of hunger or is torn to pieces by wild beaſts. Kolben, who mentions this fact, having reproached them for this inhumanity, they replied, that the Dutch ſhowed much greater cruelty to their ſick; "for you leave them (ſaid they) to periſh gradually, amidſt long and lingering pain; whereas we free them at once from all their torment." The Kamtſchatkans and Jakutians do the ſame thing: they build huts for their ſick in a foreſt, leave them there with ſome food, and pay no further attention to them.

The

The ſavage Americans of Brazil, according to Piſo, put to death thoſe who laboured under incurable diſeaſes. When any perſon in the province of Terra Firma was ſick, he was carrried by his relations to the neareſt mountain, where he was put into a hammock which was ſuſpended from a tree, and the relations danced and ſung around it the whole day. They then left food and drink to ſerve him for ſeveral days, and departed. If he recovered his ſtrength ſo far as to be able to return home, they received him with every demonſtration of joy; if he remained ſick, they provided for him a new ſupply of food and water; but if they found him dead, he was immediately put into a deep hole made on the ſpot, with a little food and water.

10. *Virginity little valued among the Barbarians.*

Marco Polo, in his deſcription of the eaſtern countries, ſays, that in the kingdom of Thibet it was not cuſtomary to marry a virgin. Married women carried their daughters to ſtrangers, that they might cohabit with them during their ſtay in the country: and when a young girl ſeparated from her lover, ſhe requeſted from him ſome ſmall preſent, as a memorial and a token that ſhe had ſlept with him. This ſhe wore as an ornament when ſhe went abroad; and thoſe who had the greateſt number of ſuch marks were always moſt eſteemed. The ſame thing is related by Rennefort of the inhabitants of Madagaſcar, and by Gerber of the people of Tauliſtan.

In Brazil, the young women before they are married reſign themſelves, without ſhame, to the embraces of the unmarried men. Their relations frequently offer them to the firſt perſon that occurs; ſo that, according to the teſtimony of Leri, not a ſingle virgin is found among thoſe who enter into the ſtate of marriage. The ſavages of Quito, according to Ulloa, are ſo fooliſh as to imagine, that if the perſon they have choſen for their bride has not before had intercourſe with another man, it is an undoubted ſign of her not being of great value. To their honour, however, it muſt be added, that when they once enter into the ſtate of wedlock they abſtain from all intercourſe with other men; and among theſe people adultery is puniſhed with death.

Among ſome ſavage nations, however, it is cuſtomary for the men to proſtitute their wives. It is aſſerted by Muller that this is the caſe among the Tſchukti; and Regnard gives the ſame account of the Laplanders. In Cumana, a diſtrict of the continent of South America, a woman does not loſe her honour or reputation if ſhe ſubmits to the embraces of

another man by the conſent of her huſband. But if ſhe does ſo without his knowledge he has a right to put her to death.

Theſe accounts might be conſidered as fabulous, were they not confirmed by different authors ancient and modern, laity as well as clergy, ſome of whom were eye-witneſſes to what they relate. Herodotus, ſpeaking of the Thracians, ſays that they permitted their daughters to have promiſcuous intercourſe with whomever they pleaſed. We are told by the ſame author that it was a law among the Babylonians, that all the women of the country ſhould, once in their lives, expoſe themſelves to the embraces of ſtrangers in the temple of Venus. Each ſat in a particular place, ſeparated from the other by a rope ſtretched between them; and durſt not move from her ſtation till ſome one threw a piece of gold into her lap, and made her retire with him. The handſome women were ſoon engaged; but the ugly ſometimes remained a long time, even three years, without being ſolicited by any one. On this occaſion, the prophet Baruch, a much older writer than Herodotus, ſays, that the one were ſoon ſet at liberty, but that the others, who were obliged to remain ſitting, were expoſed to ridicule, becauſe they had not been thought worthy of having their girdle unlooſed. Strabo gives exactly the ſame account of this circumſtance as Baruch and Herodotus do.

Another cuſtom among the ſavages, no leſs ſingular, is what is called their marriage proof. In the kingdom of Congo, in Africa, young people of both ſexes beat each other, in order to ſee whether they can endure each other. Both are equally at freedom to ſeparate, in caſe they do not ſuit each other. Ulloa mentions a like cuſtom among the Indians of Quito. I remember to have read ſomewhere that this cuſtom prevailed formerly in the Britiſh iſles, and that it is ſtill practiſed in ſome parts of Ireland and Scotland.

Were I to enlarge further on this ſubject, a whole book might be formed of the manners and cuſtoms which the Americans have in common with the people of other quarters of the globe. But, that I may come nearer to the object in queſtion, I ſhall here take a ſhort view of the ſingular cuſtoms which the Americans have in common with the Chineſe and the inhabitants of the weſtern part of Africa excluſively.

II. *Compariſon of the Americans with the Chineſe.*

1. The Peruvians had four grand feſtivals in the courſe of the year; the principal of which was held at Cuſko, the capital of the country, immediately after the ſolſtice; the ſecond and

and third were celebrated at the time of the equinoxes; the fourth had no fixed period. These festivals of the Peruvians have a great similarity to those of the Chinese, both in number and the times when celebrated; with this difference, that the Chinese observe with great attention the four periods of the year, viz. the two solstices and the two equinoxes.

2d, The Peruvian and Chinese monarchs both assumed the title of Children of the Sun, from which deity they pretended to be descended.

3d, Within the city of Cusko was a field which no one was allowed to cultivate but the Peruvian monarchs and their family. This affords a new reason for conjecturing that the Peruvians were a Chinese colony; for the monarchs of China retained also a piece of land, which was set apart for them and their family.

4th, To this we may add, that the Chinese and the Peruvian monarchs were invested with spiritual as well as temporal power, and that the political establishments in both countries were excellent of their kind.

5th, The Creole ladies in Peru, according to the testimony of Frezier, are exceedingly fond of small feet. Those who have the smallest are reckoned more perfect than the rest; and therefore their feet are confined, at a very early period, in narrow shoes. Who does not know that among the Chinese women small feet are accounted a great beauty? This custom may have come also from China; though Frezier alludes only to the Creoles, and not to the original inhabitants of the country; for it may have been introduced before the arrival of the Spaniards in Peru; and, if that be the case, the Creole ladies received this custom from the Indians, and the Indians from their ancestors the Chinese.

6th, The Peruvians had no writing, but instead of it they made use of their *quipu*; which word, properly speaking, signifies knots, but, according to the more extensive meaning, a reckoning, catalogue, or list of something. The Chinese, before the invention of their writing, made use also of such knots to convey their ideas to distant places.

The Peruvian *quipu* were threads of different colours, each of which had its peculiar meaning; for example, yellow denoted gold; white, silver; red, warriors, &c. The Peruvians employed them chiefly for keeping accompts; in which they were so expert, that they could reckon as fast with these threads, as the readiest accomptant can in Europe with pen and ink. By this method they could calculate the number of the inhabitants in the whole country, according to their age and sex: an account was kept, by means of these knots,

of all the taxes which the inca received annually; they contained alſo the roll of all the warriors, and a liſt of the births, deaths, &c.

They denoted alſo certain words or modes of ſpeech: when the inca, for example, ſent an embaſſy to any foreign powers, the latter could comprehend the inca's meaning, though they did not underſtand the proper words. What ſome hiſtorians aſſert, that the Peruvians employed different coloured threads, with knots upon them, in the ſtead of our twenty-four letters, is entirely falſe. They could always expreſs any thing, together with the circumſtances of time and place, but never the meaning in literal words; much leſs were theſe knots a ſubſtitute for hiſtorical books. Garcilaſſo de la Vega, therefore, a deſcendant of theſe incas, did not compoſe his hiſtory from information preſerved by means of theſe parti-coloured knots, but from the oral tradition of his predeceſſors.

In a word, theſe *quipu* were merely arbitrary; for they could be changed at pleaſure, and arranged in a quite different manner. The incas, therefore, did not always adopt the ſame arrangement; but, according to the nature of the thing, changed one colour for another, ſuited to the meaning they had aſſigned to them. If the Peruvians, therefore, came originally from another quarter of the world, they are deſcended, in my opinion, from the Chineſe. The diſtance between theſe two nations is, however, too great; whether they traverſed the Pacific ocean, paſſed through the ſtraits of Magellan, or, what amounts to the ſame thing, doubled Cape Horn. The laſt way is longer than the firſt, and by far too difficult and dangerous. Their paſſage through the Pacific ocean may have been occaſioned by ſome accident; though, in my opinion, they did not all arrive at the ſame period. They might land on ſome of the iſlands which they found by the way, reſt there for a time, and provide themſelves with a further ſupply of proviſions. It may, however, be objected, that the Chineſe ſhips were made of too frail materials to hold out during ſuch a long paſſage. But we have every reaſon to think that the Chineſe veſſels would, on the contrary, be ſufficient for that purpoſe; eſpecially as we know that the Ruſſians who live on the Jakuſk have proceeded with their paltry veſſels from the Lena, paſt the Eiſſen and Tſchuktſchi Noſs, as far as the mouth of the Anadir; which the largeſt and ſtrongeſt built ſhips employed for the expedition ſent out under the empreſs Anne, and which coſt ſo much expenſe, could not have done. Who firſt peopled Solomon's iſlands, between Aſia and America, which were diſcovered under the reign of Philip II.; and, according to the teſtimony of Ulloa,

were

were found to be inhabited? The Americans had no ſhips; and conſequently it muſt have been done by the Chineſe, although the paſſage from China is much longer than that from America.

This conjecture receives conſiderable weight from Deguignes, who has diſtinguiſhed himſelf by his knowledge of the oriental literature and hiſtory; for he ſays expreſsly, that the Chineſe, about the year 458, carried on a great trade to America from the north-weſt part of California: and this opinion is adopted by Buache the geographer, who calls the country Quivara. If it be true, therefore, that the Chineſe diſcovered Quivara, it is poſſible that they or their deſcendants may have gradually proceeded along the coaſt to Peru, and that a part of them may have ſettled there. It is not improbable that Mango Capac, the firſt inca, and founder of the great kingdom of Peru, and his followers, were Chineſe.

This alſo may be taken into conſideration, that navigation among the different nations of the globe has never been on the ſame footing and in the ſame ſtate. The caſe is the ſame in this reſpect as with commerce, the arts, and the ſciences. They are conveyed from one nation to another, and, by their influence, convert ignorant ſavages into enlightened people, and civilized and poliſhed nations into rude barbarians. Who were more expert in navigation and trade than the Phœnicians? They founded important colonies both in Africa and Europe, and carried on a great trade on the Atlantic. The Egyptians coaſted along the whole peninſula of Africa, proceeding from the Red to the Ethiopic ſea; then round the Cape of Good Hope to the Atlantic; thence to the Mediterranean, and ſo back to Egypt. The Greeks had large fleets both for the purpoſes of war and of commerce. They deſtroyed the naval power of Xerxes, and by theſe means reſtored the freedom of their country: but the importance of theſe people has vaniſhed, and they muſt now groan under a foreign yoke till it ſhall pleaſe Providence to ſend them a deliverer.

12. *Compariſon of the Americans with the Africans on the weſtern Coaſt of Africa.*

Among the people of the Old World, who in their cuſtoms and manners bear a reſemblance to the Americans, of which ſome inſtances have been already given, we ought to comprehend, in particular, the inhabitants of the weſtern coaſt of Africa. They have more cuſtoms, &c. in common with the American nations than all the other people of the earth,

and from them alone it would appear that the Americans are deſcended. Of this I ſhall here give a few proofs.

1ſt, The Hottentot women, from the age of twelve, always wear thongs of ſheep or calves ſkin wrapped round their legs from the knee down to the ancle bone. The inhabitants of the Caribee iſlands, in America, bind ſimilar thongs around the legs of their women after the age of twelve, only with this difference, that the latter are of cotton. This difference is owing to the Hottentots having plenty of cattle and ſheep, in which the Caribs are deficient. The women, therefore, alone wear ſuch bandages on their legs; the reaſon of which perhaps is, that the women go out to the fields and woods to labour, and conſequently muſt ſecure their legs and feet from being pricked by briers and thorns.

2d, When a Hottentot widow intends to marry again, for each huſband with whom ſhe is afterwards united ſhe muſt cut off a joint of one of her fingers, always beginning with the little finger. The Tucumans, a people of Brazil, have a ſimilar cuſtom; for on certain occaſions, but of a different nature, they muſt cut off one finger of the left hand. The Hottentot women cut off a joint when they marry again, but the Brazilians cut off their fingers on the death of their neareſt relations.

3d, The Hottentot and the Carib women bend the limbs of their deceaſed friends till they aſſume that form which they had in the mother's womb.

4th, The idolatrous negroes in Africa have almoſt the ſame religious ceremonies as the Americans, but it would be too tedious to enumerate them. Thoſe deſirous of making the compariſon may peruſe the account of George Candidius, the Dutch clergyman.

I have concluded, from the cuſtoms common to both nations, that the Peruvians are deſcended from the Chineſe, though they are ſeparated by an extenſive ocean. If this be probable, the probability in regard to the inhabitants of the weſtern coaſt of Africa is ſtill greater, for of all people of the earth theſe approach the neareſt to the Americans. Theſe two people, however, are ſeparated by the Atlantic; but the breadth of it from Guinea to Brazil is not more than twenty degrees; and beſides this, an eaſterly wind generally prevails in that ſea, which ſometimes drives the European ſhips to the coaſt of Brazil. I am not, however, of opinion that America was peopled from China and the weſtern coaſt of Africa alone. As the ſmall boats of the Laplanders, which can carry only one man, and which are employed for catching

ing ſeals, have a great reſemblance to thoſe of the Eſquimaux Indians and the Greenlanders, there is ſome reaſon to conjecture that the northern part of Europe has alſo contributed to the peopling of America *.

XXXVII. *An Eſſay on Bleaching; with the Deſcription of a new Method of Bleaching by Steam according to the Proceſs of* C. CHAPTAL; *and on its Application to the Arts. By* R. O'REILLY, *of the Academy of Bologna, Member of the Lycæum of the Arts, &c.*

[Continued from p. 111.]

Of Cotton.

COTTON is a filamentous ſubſtance, or a kind of down, which envelops the ſeeds of the cotton plant. This plant or ſhrub comes from the eaſt, and grows only in warm climates.

This ſubſtance, after being ſeparated from the ſeeds, is always charged with a coarſe colouring matter, which ſoils it, and renders it opake. The preſence of this unctuous matter is proved by the ſlowneſs with which cotton abſorbs water before it is ſcoured, and by the force with which it abſorbs it after the operation; by which means, from being opake, it is rendered clear and tranſparent.

Cotton varies a great deal in its qualities, according to the different kinds, the climate where produced, and the culture employed. Its colour is ſometimes yellow and ſometimes white, but in general it is of a dirty yellow.

To bleach it, does not require the ſame preparations as

* In a little known work intitled *An Account of the Iſlands of Orkney*, by James Wallace, M. D. and F.R.S. London 1700. 8vo. it is ſtated, p. 60 and 61, that North Americans and Greenlanders, called there *Finn-men*, have been ſometimes driven in their ſmall leather boats to the Orkney iſlands by the ſtorms and currents. In the year 1682 a ſtranger of this kind arrived in his boat at the extremity of the iſland Eda, where a great number of the inhabitants aſſembled to ſee him; but, on a boat being ſent out to catch him, he ſoon made his eſcape. About the year 1684 an American, perhaps the ſame perſon, made his appearance at the iſland of Weſtram. If it was poſſible for theſe ſavages to get to the Orkneys in ſuch wretched veſſels, the paſſage from thence to America would be much more poſſible in the worſt veſſels employed by the Europeans. Many of the fables related in regard to Tritons and Syrens, ſaid to have been ſeen formerly on the coaſts of Europe, might perhaps be explained by ſimilar circumſtances of Greenlanders or Eſquimaux Indians, driven thither in the like manner. According to Dr. Wallace, an Indian canoe, with a paddle and arrows, driven on ſhore at the Orkneys, was preſerved in the muſæum of the college of Edinburgh. Another is preſerved in the church on the iſland of Burra.

hemp and flax. The firſt operation conſiſts in ſcouring it in a ſlightly alkaline ſolution, or, what is better, by expoſure to ſteam in an apparatus we ſhall deſcribe hereafter *. It is afterwards put into a baſket, and rinſed in running water. The immerſing of cotton in an alkaline ley, however well it be rinſed, always leaves with it an earthy depoſit. It is well known that cotton bears the action of acids better than hemp or flax; that time is even neceſſary before the action of them can be prejudicial to it; and, by taking advantage of this valuable property in regard to bleaching, means have been found to free it from the earthy depoſit by preſſing down the cotton in a very weak ſolution of ſulphuric acid, and afterwards removing the acid by waſhing, leſt too long remaining in it ſhould deſtroy the cotton.

Of the Oxygenated Muriatic Acid.

This acid is one of the moſt valuable diſcoveries of modern chemiſtry, for which we are indebted to Scheele. Berthollet is the firſt who applied it to bleaching, after having carefully examined its properties.

The muriatic acid is greedy of oxygen, and takes it from almoſt all its combinations: to its union with oxygen it is indebted for its deterſive property. Manganeſe, a metal comparatively of little value, preſents an immenſe reſervoir of oxygen, which the muriatic acid ſpeedily diſengages from it in the gaſeous form. This gas, combined with water, forms the oxygenated muriatic acid of the bleachers. Water thus ſaturated aſſumes a greeniſh-yellow colour, its odour has a ſuffocating acridity, ariſing from the emanation of the gas, which adheres little to the fluid in which it has been concentrated, and which every moment endeavours to eſcape.

This acid, then, is nothing but a combination of the muriatic acid and oxygen; but the latter principle adheres but weakly to the muriatic acid, as is ſeen by the decoloration effected by the oxygenated muriatic acid, which reſtores it to its primitive ſtate of ſimple muriatic acid.

All vegetable colours are attacked by this acid, and whitened with more or leſs celerity: this depends on their greater or leſs facility of combining with oxygen. The colouring matter undergoes a real ſlow combuſtion, which terminates by the formation of carbonic acid, which, eſcaping under the form of elaſtic fluid, produces what we call bleaching.

* The apparatus alluded to has been already deſcribed in the Philoſophical Magazine, Vol. V. p. 351, under the title, "*Account of a new Method of Bleaching Cotton.*"—EDIT.

In

In whatever manner the oxygenated muriatic acid is procured, it is evident that the oxygen adheres to it only weakly; and it is on this property that the poſſibility depends of producing ſpeedily in manufactories that action which the atmoſphere produces but ſlowly, and of bleaching in a ſpace of time proportionably ſhort.

Oxygenated muriatic acid is produced by diſtilling together ſulphuric acid, manganeſe, and muriate of ſoda, (common ſalt,) and condenſing in water the acid gas which thence eſcapes. The apparatus and proportions of the ingredients will be treated of when we come to ſpeak of the proceſſes for bleaching with this acid.

Oxygenated Muriates.

Notwithſtanding the little affinity which ſome earths and alkalies have for the oxygenated muriatic acid, means are found to combine them together, and to compoſe ſubſtances called oxygenated muriates. Of the earths, none but lime and magneſia can be conveniently converted into oxy-muriates; and the latter is even too dear to be employed. The oxy-muriate of lime is at preſent uſed at all the bleaching-grounds of Ireland. For the proceſs of preparing it we are indebted to Tennant: he combines it with the oxygenated muriatic acid under the gaſeous or liquid form; but the latter is preferable. Lime water ſaturated with oxygenated muriatic acid may be employed liquid; or, by ſuperſaturating the mixture, the earthy moleculæ may be precipitated to the bottom of the apparatus: if the liquor, which is always ſurcharged with oxygenated muriatic acid, be then drawn off by means of a ſyphon, you will obtain a reſiduum ſaturated with that principle, the paſte of which may be employed in the proceſſes of bleaching. This oxy-muriate, under the concrete form, is ſufficiently impregnated to form a bleaching ley when diſſolved in water.

The alkalies of which ſuch oxy-muriates may be formed are barytes, potaſh, and ſtrontian. The firſt and the laſt are ſtill too rare, and their price is too high, to ſuit that œconomy which the proceſſes for bleaching require; but theſe ſubſtances have begun to be diſcovered in France. In regard to potaſh, we are already acquainted with the part it acts in condenſing the oxygenated muriatic acid, and rendering it inodorous. To obtain the ſame reſults with oxy-muriate of lime, nothing is neceſſary but to ſaturate it in like manner.

The advantages obtained by theſe preparations are very important.

One is enabled to make theſe leys, and to ſend to a diſtance theſe muriates, which form the deterſive ſubſtance, without

fear

fear of their loſing their properties by the way. I have already mentioned the extreme volatility of the liquid oxygenated muriatic acid, and the almoſt impoſſibility of tranſporting it without the loſs of nearly one-half of its ſtrength; and however little it may be ſhaken in its paſſage, the acid gas will entirely eſcape. We ſhall ſhow hereafter the method of preparing and employing theſe muriates in bleaching.

Of Potaſh.

The ſubſtance known in commerce under the name of *potaſh*, and which acts ſo important a part in the proceſs of bleaching, is a ſaline matter produced by incinerating plants or wood, and lixiviating, concentrating, and calcining the aſhes. The uſe of ley of aſhes was known in the remoteſt periods; but the Germans were the firſt who taught us to concentrate the ſalt diffuſed throughout the water of the ſolution, and to which they gave the name it now bears, from the veſſels employed in the fabrication of it, viz. *potaſhes*, or potaſh.

Though potaſh be very common in nature, it is the vegetable kingdom which preſents it to us in the greateſt abundance. Chemiſts are divided in regard to the queſtion, Whether this ſalt exiſts completely formed in the plants, or is produced by the union of certain principles during the combuſtion? It is ſufficient for the bleacher to know how it is obtained, and to be acquainted with its moſt ſtriking properties; for its chemical compoſition is entirely unknown.

The method of obtaining potaſh is as follows:—Burn herbs of every kind, except marine plants, or ſuch as grow on the ſea ſhore; then lixiviate the aſhes and evaporate the ſolutions, by which means you will have a ſaline reſiduum: calcine this ſaline ſubſtance in a reverberating furnace, and the product will be potaſh. This ſubſtance, as ſoon as it is taken from the furnace, attracts the humidity of the atmoſphere; or, to ſpeak correctly, it endeavours to ſaturate itſelf with carbonic acid: in this ſtate it forms what the bleachers call *mild alkali*; it is then more detergent than ſoap, and leſs ſo than cauſtic alkali. Potaſh is exceedingly ſoluble in water; it requires little more than half its weight to diſſolve it. The potaſh of the ſhops is often adulterated with other ſaline ſubſtances, and commonly with the ſulphate of potaſh, which is purchaſed, at a low price, by the makers of aquafortis, in glaſs-houſes, &c. This ſalt degrades the quality of it, and, by its little ſolubility in water, retards the operation of bleaching. This fraud may be detected by one property; for, as ſixteen parts of water are required to diſſolve one of

this ſulphate, when the temperature of the atmoſphere is 65° F., while one part is ſufficient to diſſolve a like weight of potaſh; one needs only boil together an equal weight of common potaſh and river water for ſome minutes, leave it to reſt twenty-four hours, and then decant the clear ley; if the reſiduum be then waſhed with a fourth of the quantity of the water employed, and the clear liquor be poured off, the remaining depoſit will be compoſed of foreign ſalts or heterogeneous matters, found there accidentally, or which have been employed in adulterating the potaſh.

We have mentioned the avidity with which potaſh abſorbs the carbonic acid. As this principle diminiſhes its deterſive force, it muſt be deprived of it by mixing it with twice its weight of lime; then lixiviating it, or, what is ſtill better, pouring ſaturated lime water into a ſolution of potaſh alſo ſaturated, and until the lime water ceaſes to give a precipitate. It is on this property poſſeſſed by alkalies, of uniting with oils and fat matters, of rendering them ſoluble in water, and diſengaging them from the ſubſtances with which they are mixed, that the theory of bleaching with ſoaps and alkaline mixtures is founded. This deterſive force, however, muſt be moderated. Potaſh, even in the ſtate of carbonate, attacks not only the colouring matter, but the ſubſtance, alſo, of flax, hemp, and cotton: being rendered cauſtic, its reſolving force is increaſed; it is a dangerous enemy when its agency is abuſed, but a powerful auxiliary when employed with moderation.

It is by a prudent uſe of this matter that we propoſe to employ an alkalino-cauſtic lixivium in a ſteam-apparatus for bleaching the linen of public inſtitutions: the aſhes alone of their fire-places, where the fuel is wood, lixiviated and rendered cauſtic, will be ſufficient for this operation, which will be attended with a degree of œconomy that no other proceſs can counterbalance.

Though I recommend the uſe of cauſtic leys, I am far from recommending lime applied alone or mixed with alkalies. Ignorant manufacturers, imagining that it bleaches the cloth, make uſe of it imprudently, to the detriment of their manufactures, and excuſe themſelves by the example of enlightened men, who add lime to render the alkalies cauſtic; but every chemiſt knows that, notwithſtanding this addition, there does not remain *a ſingle atom of pure lime* in the alkalino-cauſtic liquor when it has been made with the neceſſary precautions.

Of

Of Soda.

Nature preſents us with ſoda in ſtill greater abundance than potaſh; and it is even found in a pretty pure ſtate in Egypt, where it is collected at the bottom of the lakes. The combuſtion of plants, and the different kinds of *ſaltwort* or *ſoda* which grow on the ſea-ſhore, furniſh it in great abundance: it is from this plant that it takes its name. But modern chemiſtry has taught us how to obtain it in ſtill greater profuſion by the decompoſition of ſea ſalt (muriate of ſoda).

Its properties in regard to bleaching are nearly the ſame as thoſe of potaſh, with this exception, that it does not unite itſelf to the oxygenated muriatic acid; in general, the action of ſoda, even when cauſtic, is much weaker; and it attacks cloth and ſtuffs much leſs than potaſh. We ſhall therefore make choice of it in preference for our proceſs of bleaching with ſteam.

Soda is generally more mixed with heterogeneous matters than potaſh, and the fraud is more difficult to be detected. In this caſe, recourſe muſt be had to repeated cryſtallizations. Kirwan, in his excellent memoir, recommends boiling the ſoda in three times its weight of water; ſuffering the ſolution to remain at reſt; then filtering it, and boiling the reſiduum left on the filter with half the quantity of water, and making it again paſs through the filter. Soda, being cauſtic, requires ſome days expoſure to the air before it cryſtallizes. If it be of a bad quality, it will not form cryſtals in five or ſix days: if the contrary be the caſe, the ſalt is extracted, the mother water is reduced to one half, and it is again ſuffered to cryſtallize. This reſiduum is once more expoſed, and this proceſs is repeated till the whole of the cryſtallizable ſoda has been extracted. If the ſoda has been adulterated by a great deal of lime, it will be ſoon detected by diſſolving an ounce of common ſoda in boiling water, and letting fall into it a drop of corroſive muriate of mercury: if the liquor aſſumes a brick colour, it contains a little lime: the quantity of this ſubſtance may be appreciated, in ſome meaſure, by the intenſity of the yellow ſhades which its preſence produces.

Of Soap.

The property I have already mentioned as inherent in alkalies, of combining with oils and fat animal matters, forms the baſis of the proceſs for making that deterſive ſubſtance called *ſoap*. There is a very prominent line of demarcation between ſoap obtained by means of ſoda and that furniſhed by

by potaſh. Soda gives a hard ſoap; potaſh, on the other hand, a ſoft kind. Pliny aſcribes to the Gauls the invention of this valuable compoſition. The ſoap of our anceſtors was formed of goat's greaſe mixed with the aſhes of beech wood; and ſeveral improvements were ſucceſſively introduced into the manufacturing of this ſubſtance, as chance, the mother of the moſt important diſcoveries, pointed out the neceſſity of them. The progreſs of the arts towards perfection has been very ſlow, on account of the prejudices of that ignorance which prevailed in the paſt ages. We have, however, now reached a period when the ſciences and the arts, aided by their reciprocal reſources, are advancing rapidly towards a certain degree of perfection.

In France, two kinds of ſoap only are made—hard ſoap, and ſoft ſoap: the firſt with ſoda and olive oil; the ſecond with potaſh, and vegetable oils of leſs value.

In Hungary, ſoap is made of tallow and natron; as is the caſe in ſeveral parts of Germany and Ruſſia. The Ruſſians make a hard ſoap alſo with bad ſalt butter; but this kind is not much eſteemed; its rancidity and the quantity of ſalt and caſeous matter found in it degrade its quality. Wiegleb aſſerts that a very hard ſoap, which has a very agreeable ſmell of almonds, is made with yellow and white wax.

The Engliſh, as they have not vegetable oils in abundance, make ſoap only with tallow or fiſh oil, ſometimes with kitchen-ſtuff or ſpoilt butter. They have four kinds. 1ſt, White ſoap, made with ſoda of Alicant, or the ſoda of Varech, and tallow. 2d, Marbled ſoap, made of tallow and kitchen-ſtuff. The marbled appearance does not ariſe from an oxide, as among us, but becauſe a little of the ley is diſperſed throughout the whole maſs. 3d, A hard yellow kind of ſoap, compoſed of ſoda, tallow, and reſin. This laſt ſubſtance is introduced only for the purpoſe of rendering the ſoap cheaper, but it certainly does not augment its deterſive ſtrength. The fourth kind of ſoft ſoap is formed of whale or fiſh-oil and potaſh.

It was long an object of reſearch to diſcover ſubſtances which might be ſubſtituted for oil and tallow in the fabrication of ſoap. It was reſerved for Chaptal to lay open this field by his important diſcovery of a proceſs for ſaponifying wool, and converting into excellent ſoap rags of old cloth and worſted, the waſte of carding, and the other refuſe of cloth manufactories. This diſcovery gave riſe to that of ſir John Dalrymple, who ſuppoſed that, by a method ſimilar to that of Chaptal, it would be poſſible to convert the muſcular part of fat fiſh into ſoap; and ſome experiments, crowned with complete ſucceſs, ſoon confirmed him in this idea.

Thoſe

Thoſe who wiſh to acquire information reſpecting the art of ſoap-making may conſult the excellent work of Darcet, Pelletier, and Lievre, publiſhed a few years ago by the order of the French government.

Sulphuret of Lime.

Lime and ſulphur are two ſubſtances which nature preſents to us with profuſion. They combime perfectly together. Their union is called *ſulphuret of lime*, and they then form a very active detergent matter. Kirwan firſt obſerved that ſaline ſulphurets, or the combination of an alkali with ſulphur, might be employed with advantage in bleaching on account of their *deterſive* properties, and even ſupply the place of alkalies. What Kirwan propoſed was executed by Higgins in Ireland; and by analogy of reaſoning he was led to the diſcovery of the detergent power of ſulphurets of lime.

In whatever manner theſe ſubſtances are combined, the reſult is always the ſame; either in the dry way, by fuſing them together, which produces a very ſtrong and very ſolid ſulphuret; or by uniting quicklime and ſulphur, and pouring over them eight or nine times their weight of water; the heat alone of the lime while ſlaking will be ſufficient to combine them: or, in the laſt place, by following the proceſs of Higgins, which conſiſts in boiling together ſlaked lime and ſulphur. The laſt method is that which ought to be preferred for bleaching.

The liquor which reſults from this union of water, lime, and ſulphur, is *liquid ſulphuret of lime:* it is of a dark yellow colour, and has a harſh ſtyptic taſte; it emits an odour ſomewhat ſimilar to that commonly perceived in ſulphur and ſlaked lime. This emanation, however, is not of a noxious nature like that of the oxygenated muriatic acid.

Liquid ſulphuret of lime loſes its colour by expoſure to the air, and ſpeedily abſorbs the oxygen of the atmoſphere. Theſe properties deſerve the attention of the bleacher, as they will ſhow the advantage of employing this ſolution as freſh as poſſible, leſt the quality of it ſhould be hurt; and they explain a part of the principles, according to which liquid ſulphuret of lime exerciſes an action in the art of bleaching.

From the above obſervations the following practical principles may be deduced:

Sulphuret of lime, of all the alkaline compounds, is the moſt powerful ſolvent of the colouring matter of flax; cauſtic potaſh is the next; then cauſtic ſoda; then common potaſh; and, in the laſt place, common ſoda. Sulphur, if employed pure, ſtains cloth a little; but the ſtains may be eaſily removed

moved by the application of potaſh. The alkali ariſing from the combuſtion of plants is more powerful than the mineral alkali, as I have already obſerved. The alkaline ſulphuret, which is formed by the combination of ſulphur and ſoda, is far from poſſeſſing ſo deterſive a quality as that made with potaſh.

Various Proceſſes for Bleaching Hemp, Linen, and Cotton.

Having already ſpoken of the different methods hitherto purſued for bleaching vegetable ſubſtances, and examined the menſtrua and deterſive ſubſtances moſt uſed in the various proceſſes, I ſhall proceed to a deſcription of the different manipulations to which theſe matters are ſubjected in order to give them that degree of whiteneſs which is neceſſary to fit them for commerce.

Bleaching in the open Air.

The air with which the earth is ſurrounded is far from being homogeneous. Every thing volatilized on the ſurface of the globe; all the emanations of the earth, as well as the beneficent fluids, which aſſume the gaſeous form, are confounded in this aëriform ſea by which we are ſurrounded. It is an immenſe laboratory always in action, where the play of compoſition and decompoſition is inceſſantly renewed.

Of the numerous properties of the atmoſpheric air, it will be ſufficient if we mention only a few. About a fourth of this fluid is compoſed of a gas, which appears to be the acidifying principle: this is oxygen, which readily ſuffers itſelf to be abſorbed by a great number of bodies, among which are carbon. This union with carbon forms carbonic acid, which is alſo an aëriform fluid.

Without calling in queſtion thoſe principles for which we are indebted to modern chemiſtry, mankind have at all times employed free air as the moſt convenient menſtruum for bleaching. When tired with the ſlowneſs of its action, they aſſiſted it by deterſive leys, which abridged the proceſs a little; and this union of boiling, and expoſure on the graſs, formed the whole of the antient art of bleaching. Formerly, when it was neceſſary to bleach cloth, it was cuſtomary to immerſe it in pure water to free it from the dreſſing. This preliminary operation was ſometimes haſtened by a cold ley, the cloth was then rinſed in running water and ſpread out on a meadow, round which ran a ſtream of limpid water that ſerved for watering the different pieces.

After being expoſed in this manner for ſome time, the cloth was waſhed and boiled in a freſh ley; it was then again

ſpread

ſpread out on the graſs; and this operation was ſeveral times repeated until the required whiteneſs was obtained. It was ſtill neceſſary to wind it through ſoapy water, not only to give it ſoftneſs and pliability, but to bleach completely the borders, which oppoſe the longeſt reſiſtance.

It was brought to its ultimate ſtate of whiteneſs by drawing it through whey or diluted ſulphuric acid. By this ſhort deſcription it may be ſeen that a conſiderable time was neceſſary before the abſorption of oxygen could take place: to haſten this operation of nature appeared impoſſible, until modern chemiſtry had demonſtrated that oxygen, ſolidified in various bodies, might be extracted and combined with water, to be afterwards applied to ſubſtances where its influence might be neceſſary.

Bleaching by Water alone.

I have already obſerved that, during the fermentation that takes place in the vats in which cloth is immerſed to free it from the dreſſing, the fibres aſſume the firſt tint of whiteneſs. It had been before remarked that the percuſſion of ſtampers in paper manufactories bleached, in ſome degree, the pulp impregnated with water; it was known that, by ſuffering hemp and flax to ferment a very long time, a greater degree of whiteneſs was obtained, but always at the expenſe of the fibrous tiſſue, deſtroyed by too long maceration. Taking advantage of theſe obſervations, Braſſe, an artiſt of Amiens, found means to bleach hemp and linen by the action of water alone.

When the hemp was pulled, he watered it a little longer than uſual, having previouſly cut off the roots by laying the ſtalks on a board furniſhed with an inſtrument deſtined for that purpoſe. When the cortical tiſſue was attacked, and deſtroyed by the putrid fermentation, he removed the hemp from the water, and, by drawing it through a kind of heckle or comb, completely ſeparated the fibrous tiſſue, which, on account of its parallelism, was not hurt by the teeth of the inſtrument; while the reticular tiſſue of the bark or exterior covering, already half putrid, ſtuck on the points, and readily ſuffered itſelf to be ſeparated from the hemp. During this operation the hemp was immerſed ſucceſſively in water, between each ſtroke of the heckle, to facilitate the removal of the green matter above the bark. The whiteneſs which hemp aſſumes by this ſingle operation can hardly be conceived: it acquires a ſplendour and brilliancy which can never be communicated to it by the uſual proceſſes, but its ſtrength is alſo diminiſhed as well as the product by the too great progreſs of the fermentation;

mentation; on the other hand, this hemp may be employed with great advantage in the arts. It is here proper to obſerve, that bleaching by water never gives complete whiteneſs, like the uſual proceſſes of the bleach-field. To finiſh the bleaching of hemp, it would be neceſſary to have recourſe to the different means deſcribed in this eſſay.

Of Bleaching with the Oxygenated Muriatic Acid alone.

In this proceſs oxygenated muriatic acid is ſubſtituted for the action of the air, and preſents itſelf with advantage, becauſe its oxygenating principle is not drowned in a chaos of different fluids, like the oxygen of the atmoſphere; its action, too, muſt therefore be ſpeedier. As I have already examined the principles of this acid, and its intimate nature, I ſhall now proceed to the application of it, and to a deſcription of the beſt apparatus.

The matters which ſerve for the production of the oxygenated muriatic acid are manganeſe, common ſalt, (muriate of ſoda,) and the ſulphuric acid. Manganeſe is a metallic oxide very much diffuſed throughout the ſurface of our globe, and which may be procured at a ſmall expenſe. The greater part of it is brought to us from Macon, Saarbruck, and Hombourg in the ci-devant duchy of Deux-Ponts: it muſt be choſen well cryſtallized in ſmall black brilliant needles; and it is neceſſary to avoid with care thoſe blackiſh maſſes, which often contain heterogeneous matters, and, at any rate, the matrix of this mineral. In order to employ it with advantage, it ſhould be pounded before the mixture is made for diſtillation.

The ſulphuric acid (oil of vitriol) ought to be concentrated; that ſold in the ſhops generally ſhows 60 or 66 of the areometer: it muſt be taken as nearly as poſſible at that term, in order to avoid errors in the proportions of the ſubſtances neceſſary for the diſtillation of the oxygenated muriatic acid; proportions founded on an uniform concentration.

The ſalt to be employed ought to be white, and well cryſtallized; it muſt alſo be dried, and the cryſtals, if large, muſt be pounded, in order to facilitate the mixture with the manganeſe.

The proportions generally obſerved are, one part (by weight) of manganeſe; two of ſulphuric acid, diluted with a little more than its volume of water; and three of ſalt. The better theſe matters are combined together, the more eaſily will the acid gas be diſengaged by the action of the ſulphuric acid. It is proper alſo to remark, that the acid ought to be diluted in a leaden veſſel; for, if other veſſels were employed,

they might break in conſequence of the heat produced by the union of the acid in water. In ſome places theſe proportions vary. In England, the following are uſed:

Manganeſe - -	30 parts.
Common ſalt -	80
Sulphuric acid -	60
Water - -	120

Such is the ley employed at Mancheſter, where nothing is bleached but cotton cloth, and cotton and thread.

In Ireland, the proportions are:

Manganeſe - -	60 parts.
Salt - -	60
Sulphuric acid -	50
Water - -	50

This is the common ley of thoſe who bleach linen cloth; and hence we may explain the great difference between theſe and the preceding proportions.

In Germany the doſes vary a little, and approach near to the proportions uſed in the French manufactories. They are:

Manganeſe - -	20 parts.
Salt - -	64
Acid - -	44
Water - -	54

The neceſſity of diſtilling this acid on a large ſcale, has given riſe to the invention of different kinds of apparatus more or leſs convenient. Berthollet has propoſed matraſſes with bent tubes, which convey the oxygenated muriatic acid to the pneumatic tub, in which the bubbles, traverſing the water, are forced, by means of an agitator, to combine more or leſs with it. Pajot de Charmes recommends the uſe of tubulated retorts; but, beſides theſe veſſels being too dear, they do not anſwer the propoſed end, ſince a portion of ſulphuric acid not decompoſed, and which injures the proceſs, always paſſes into the water.

C. Widmer, at Jouy, has arranged his apparatus in ſuch a manner as to loſe the leaſt gas poſſible during the condenſation: he receives the gas under a capſule inverted at the bottom of the apparatus; above theſe are two *tours de goutiere* alſo inverted, then another capſule above theſe; then two more *tours de goutiere*, and then another capſule, which terminates the apparatus. The diſpoſition of his tub is ſuch, that he places around in his laboratory ſeveral diſtilling apparatuses, which are going at the ſame time.

Apparatuses conſtructed on ſimilar principles are alſo in uſe at Glaſgow and Mancheſter. Bourboulon-de-Bonneuil has likewiſe invented an apparatus, conſiſting of ſeveral matraſſes,

traſſes, ranged as in an aquafortis manufactory, the tubes of which are conveyed into a chamber containing concentrating tubs. His apparatus for the bleaching of paper is very ingenious, and deſerves to be deſcribed. In the laſt place, others have arranged five or ſix large caſks, like Wolf's apparatus, in ſuch a manner as to make each caſk perform the functions of a tubulated flaſk. The bleachers in Ireland employ a kind of leaden alembic capable of containing forty gallons of water; a capacity more than ſufficient to contain the charge, and to favour the ſwelling which takes place by the reciprocal action of the matters during the diſtillation. This alembic, (ſee Plate IV.) of a conical form, and having a very broad baſe, reſts in a balneum mariæ, in order that it may be ſubjected to a progreſſive heat; and the neck is of ſuch a height, that any ſulphuric acid which happens to riſe may fall back. The cover is perforated to afford a paſſage to the handle of an agitator, which ſerves to ſtir the matters at the bottom of the alembic: this agitator is of iron as well as its arms; but the iron is covered with a pretty thick plate of lead, that the acid may not attack it: the handle goes through a leather collar, to prevent the eſcape of the gas. The ſulphuric acid, diluted with water, is introduced into the leaden apparatus by means of a ſmall glaſs or leaden funnel, the tube of which is bent to guard againſt the reaction of the gas. The apparatus is alſo furniſhed with a condenſer, into which the gas is made to paſs. This veſſel has ſeveral ſhelves and an agitator. The latter goes through a leather collar in the top of the condenſer, paſſes down through the ſhelves, and is furniſhed with arms between each of the ſhelves; by which means the gas in its aſcent is expoſed to the action of the liquid in a ſtate of great agitation, and has a long way to travel through it. (See the Plate.)

I ſhall now ſpeak of an apparatus which, in my opinion, is free from thoſe faults which generally attend an apparatus of lead, which always becomes oxidated, and is at length deſtroyed. This apparatus * conſiſts of a ſeries of conical matraſſes with long necks, furniſhed with bent funnels as well as tubes, both of glaſs, which are conveyed into a common reſervoir. This reſervoir ought to be perforated in ſuch a manner as to leave room for the introduction of a tube of a larger ſize (two inches) communicating with the firſt condenſing caſk or cylinder, made of white wood, twenty inches in diameter, bound round by hoops made tight with ſcrews, and completely water proof. Care muſt be taken to cover theſe hoops

* See Plate II. fig 1 and 2, given in our laſt Number; and the deſcription, page 101 and 111.

with a coating of japan, as it is called, or with oil paint, to prevent the oozings of the liquor from ruſting them. The height of this cylinder muſt be ſeven or eight feet, and even more, if poſſible, in order to increaſe the preſſure; and ought to have placed over it a large two-necked bottle deprived of its bottom, or a glaſs bell with two necks cemented to the upper edge of the cylinder. In one of theſe necks the large tube of the reſervoir is introduced, and made to deſcend to the bottom of the cylinder. The air bubbles, as they are diſengaged, being forced to traverſe the fluid under a preſſure equal to the height of the column of water, will combine with it until it be ſaturated; the ſecond neck is alſo furniſhed with a bent leaden tube, the orifice of which is below the ſurface of the water; the ſuperabundant gas paſſes through this tube, and, deſcending into the ſecond cylinder of wood, ſimilar in all reſpects to the preceding, ſaturates the water in it:—a third cylinder may be added, if judged neceſſary. By this arrangement the ſmalleſt portion of the gas cannot eſcape: care muſt be taken to apply a leaden cock at the bottom of each cylinder, in order to draw off the bleaching liquor as it is formed.

The reſiduums, after the diſtillation of the oxygenated muriatic acid, may be ſold to earthen-ware manufacturers to be employed as a glazing for their coarſe articles. The manganeſe contained in it gives it a blackiſh appearance, like that of bronze, which is far from being diſagreeable to the eye. I have employed this glazing ſeveral times by way of trial; firſt fuſing it with ſand in a potter's furnace, throwing it into cold water to facilitate its diviſion, and grinding it in a mill in order that it might be diffuſed in water. This glazing is attended with the advantage of being free from thoſe dangerous qualities ſo common in all preparations made from the oxides of lead; but the moſt important object is the extraction of the ſoda from the ſulphate of ſoda, which is formed in great quantity by the proceſs, and remains in the reſiduum of the diſtillation.

The firſt point is, to convert the ſulphate of ſoda into an alkaline ſulphuret. Malherbe and Athenas have ſucceeded in this by employing iron as the intermediate ſubſtance: they mixed one part of charcoal duſt with nine parts of the ſulphate of ſoda, and expoſed the mixture to the heat of a reverberating furnace: when the ſulphuret entered into combuſtion, they added from three to five parts of old iron rendered as ſmall as poſſible; and the whole being fuſed together, they obtained a black paſte, compoſed of iron, ſoda, ſulphate of iron, &c. This mixture was lixiviated, and fil-

tered through a baſket filled with lime: it was then evaporated to dryneſs, and the reſiduum was calcined in a reverberating furnace. When ſoda of a ſuperior quality is required, the waſhing and calcination muſt be repeated.

Dizé and Le Blanc decompoſed the ſulphate of ſoda, by means of the carbonate of lime, in order to neutralize the alkali, by ſaturating it, at a very high temperature, with carbonic acid. Their proceſs conſiſts in taking two parts of ſulphate of ſoda, dried to deprive it of its water of cryſtallization, two parts of well ground chalk (carbonate of lime), and one part of charcoal powder, mixing them well in a muffled mortar, and then bringing the mixture to a white heat in a reverberating furnace: when the matter is fuſed it is ſtirred till the ſulphur is conſumed, and the ebullition and the jet of the flame produced by the hydrogen gas have ceaſed to appear. It is then taken from the furnace, and it may be lixiviated to obtain the ſoda very pure. In whatever manner the ſulphate is decompoſed, this object merits the greateſt attention at bleachfields on account of the conſiderable degree of œconomy which reſults from the different manipulations. The ley of oxygenated muriatic acid will be obtained at little or no expenſe by bleachers, when they ſeriouſly ſet about extracting the ſoda from the ſulphate formed during the diſtillation.

In whatever manner the muriatic acid gas may be diſtilled, the great object is to ſaturate the water with this aëriform fluid. Its action in bleaching is always ſtronger when employed alone than when in the ſtate of combination with ſalts or earths, as in the ſubſequent operations of which I am about to ſpeak. The volatility of the acid, however, is ſuch, and the loſs of the gas ſo enormous, that, when the thread or cloth is immerſed, there is diſſipated of it a quantity which may be eſtimated at about a *third*, at leaſt, of the whole gas. The mixture of potaſh, indeed, renders the liquor inodorous; but beſides that this ſalt is expenſive, it greatly weakens the deterſive quality of the liquor.

Rupp, of Manchester, has invented an apparatus for bleaching cloth exceedingly ſimple in its conſtruction, of ſmall expenſe, and which contains the liquor in ſuch a manner as to prevent the eſcape of the oxygenated muriatic acid gas. A conſideration of no leſs importance in the arrangement of this apparatus is, the impoſſibility of the vapour injuring the health of the workmen. I have witneſſed, in a very large manufactory near Paris, the dreadful ſufferings to which theſe unfortunate people were expoſed by theſe ſuffocating vapours. I have ſeen them rolling on the ground through

pain, and ſevere maladies are often the conſequence of theſe firſt effects of the oxygenated muriatic acid. In Rupp's apparatus I have found one great inconvenience: the cloth is rolled up on a vertical axis, and when there are ſeveral pieces on it, the edges are folded back merely by the weight of the ſtuff, and conſequently have leſs whiteneſs than the reſt of the cloth. In the improvements I have propoſed this inconvenience is avoided by the horizontal diſpoſition of the pieces, and by the manner in which I make them to be wound up in the inſide of my apparatus*. For the immerſion and bleaching of thread I would propoſe the uſe of Rupp's apparatus, with ſome trifling alterations. In regard to the deſcription of my apparatus, as it has been already given in ſpeaking of the ſulphurous acid, it is needleſs to repeat it here.

Before we proceed to the manipulations, I ſhall ſpeak of an inſtrument uſed for aſcertaining the deterſive force of the ley, and which Deſcroizilles, with great propriety, calls a Berthollimetre. I ſhall alſo examine the method propoſed by Rupp.

The proceſs of Deſcroizilles conſiſts in diſſolving indigo in dilute ſulphuric acid in the following manner:—A dram of the fineſt indigo is introduced into a matraſs with ſeven times its weight of ſulphuric acid at 66 degrees. The ſolution is facilitated by immerſing the matraſs into a balneum mariæ: the ſolution of indigo is then diluted in a flaſk containing 124 ounces of diſtilled water, until no traces of it remain in the matraſs; by which means the indigo then becomes mixed with the liquor in the proportion of one to a thouſand. The inſtrument afterwards ſerves to indicate the diſcolouring force of the oxygenated muriatic acid. The method of employing it may be ſeen in the memoir publiſhed by Deſcroizilles in the year 3.

The method pointed out by Rupp appears to me to be ſimpler, and calculated to avoid thoſe errors to which the ſulphuric acid always gives riſe: he adds acetite of lead to the ſolution of indigo until the lead is precipitated, and the indigo alone remains diſſolved in the acetous acid †.

The utility of theſe means for aſcertaining the ſtrength or exhauſtion of the oxygenated muriatic acid may be readily conceived. If a certain quantity of ſtuffs or thread put into an immerſing tub of a hundred cubic feet content, is found to have reduced the acid liquor from eight to ſix degrees of

*, See Plate II. fig. 3, and 4, given in our laſt number.

† The author here details Mr. Rupp's experiments, which, having already been laid before our readers in our ſecond volume, we now omit. —Edit.

the

the Berthollimetre, there is reaſon to conclude that there has been an exhauſtion of a fourth: the ſame reaſoning may be applied by analogy to proofs by the acetite of lead.

Cloth is prepared for immerſion in oxygenated water, by ſoaking in a ley of weak potaſh, and rinſing it afterwards in a large quantity of water in order to free it completely from the weavers' dreſſing and the ſaliva of the ſpinners. In England and Ireland, machinery is employed for rinſing and beating: in ſome places this operation is performed by means of planks to which an alternate motion is communicated; but this mechaniſm wears the ſtuffs, though it greatly accelerates the operation. In place of ſuch planks, which are too long, in our manufactories we employ ſtampers, placed in very large conical tubs, the levers of which change their direction every ſtroke, paſſing ſucceſſively over the whole quantity of cloth immerſed. But the beſt method of all is beating by mechaniſm. For this purpoſe a circular platform, which performs its revolutions around a moveable axis, and is ſupported at the ends of the ſpokes by rollers of caſt iron, is employed: the circumference of this wheel is notched to receive a catch, which makes it recede one notch every ſtroke by the motion of the mill-tree. This tree bears on its axis ſpokes that raiſe ſeveral wooden beaters, which, falling on the moveable platform covered with cloth and thread, rinſe them completely: buckets attached to the water-wheel raiſe the water, and pour it into gutters that convey it under the beaters, which are thus abundantly watered.

Cotton and cotton cloth require in particular this preparation; otherwiſe the ley could not penetrate to the inſide of the cotton, on account of the extracto-reſinous matter contained in it, as we have already obſerved in ſpeaking of that ſubſtance.

In ſeveral manufactories a ley of ſoap is uſed: but all this comes to the ſame thing; that is to ſay, the combination of the oily matters with the alkali, in order to render them ſoluble in water, and then to the combination formed between a part of the colouring matter and that ſaline ſubſtance; an union moſt eſſential for bleaching. It is in theſe leys, therefore, and in rinſing in running water, followed by preſſing or wringing, to free the cotton from all filth, that the preparations which precede immerſion in the oxygenated muriatic acid conſiſt.

The apparatus muſt be arranged according to the objects to be bleached: the ſkains of thread muſt be ſuſpended in the tub deſtined for them, and the cloth muſt be rolled upon reels in the apparatus. When every thing is thus diſpoſed,

the tubs are filled with oxygenated muriatic acid by introducing a funnel, which deſcends to the bottom of the tub in order to prevent the diſperſion of the gas. The cloth is wound, or the frame-work on which the ſkains are ſuſpended is turned ſeveral times, until it is judged, by taking out a ſmall quantity of the liquor from time to time, and trying it by the acetite of lead, that it is ſufficiently exhauſted. The weakened liquor is then drawn off, and may be again employed for a new ſaturation.

It is neceſſary to immerſe alternately in oxygenated muriatic acid and alkaline leys of from a degree to a degree and a half of the areometer. The number of theſe immerſions and leys varies according to the nature of the vegetable ſubſtances. Cotton may be bleached by two operations; thread and cotton by three; fine linen by four; and hemp by five or ſix. Preſſure alone, or wringing, will be ſufficient inſtead of rinſing, when the articles are taken from the tub, and before they are ſubjected to the ley; it is even neceſſary that the carbon, generated by the action of the alkali, ſhould unite with the oxygen of the liquor to form carbonic acid, which, being afterwards expelled, forms the whole ſecret of the art of bleaching.

[To be continued.]

XXXVIII. *Some Account of the Life of* PLACIDUS FIXLMILLNER, *the Aſtronomer.*

PLACIDUS FIXLMILLNER was born on the 28th of May 1721 at Achleiten, a village in hither Auſtria, not far from Kremsmunſter. He received the rudiments of his education in the convent of Kremsmunſter, which was indebted to his uncle the abbot, Alexander Fixlmillner, for an excellent ſchool and an obſervatory. Placidus conceived an early attachment to the mathematics, and took ſo much pleaſure in delineating mathematical figures, that his mother, out of deriſion, called him the almanac-maker. After ſome ſtay at the above ſeminary he removed to Salzburg, where he completed his courſe of philoſophy, and obtained in that faculty the degree of doctor. His taſte for the mathematics, however, became ſtill ſtronger. His father having aſked him one day what preſent he ſhould give him, he requeſted Wolf's Epitome of the Mathematics; which he ſtudied with the greateſt pleaſure and ſatisfaction during ſuch hours as he could ſpare from his other avocations: but, having deſtined himſelf for the convent, he was admitted a noviciate

viciate at Kremsmunſter in 1737, and next year he publicly took the vows before his uncle, the abbot Alexander.

After a ſtay of two years in the convent his *oheim* ſent him again to Salzburg to complete his ſtudies in juriſprudence and theology; but at the ſame time he applied with great aſſiduity to the mathematics, languages, hiſtory, and antiquities. He learned alſo to play on the harpſichord and organ; and made ſo much progreſs in muſic, that he compoſed ſeveral pieces both in the ſacred and theatrical ſtyle. He diſputed in ſome theological theſes; obtained the degree of doctor in theology; and in 1745 returned to his convent, where he was conſecrated to the prieſthood.

About this time the *Ritterſchule* having been eſtabliſhed at Kremsmunſter, Placidus was appointed profeſſor of canon law; a department in which he had acquired great reputation at the univerſity. This office he held for forty years, and reſigned it only a ſhort time before his death. Almoſt about the ſame period he was appointed dean of the higher ſchool, and ſoon after principal regent over the young nobility; which places he retained alſo till his death. He poſſeſſed great knowledge of the canon laws, and on that account was often employed in proceſſes and other affairs relating to the convent: he was likewiſe inſcribed *Notarius apoſtolicus in curia Romana.*

In the year 1760 he publiſhed a theological work under the title of *Reipublicæ Sacræ Origines Divinæ*; but he acquired far more celebrity by his aſtronomical labours, both as an obſerver and a writer. The abbot Alexander Fixlmillner, a great friend of the ſciences, and particularly of the mathematics, having reſolved, in the year 1747, to form an eſtabliſhment in his convent for promoting the latter, firſt ſet apart a ſpacious apartment for the purpoſe of containing mathematical and philoſophical inſtruments. This paved the way for ſomething further; and he determined, for the improvement of his conventuals in aſtronomy, to erect an obſervatory. Among thoſe convents which for a long time have devoted their leiſure and riches to the advancement of ſcience and the good of mankind, none has diſtinguiſhed itſelf more than that of Kremsmunſter. This very old abbey is not the ſeat of infidelity and indolence, but a patron of the nobleſt branches of ſcience. The obſervatory founded in 1748 was completed in 1758, and the ſuperintendence of it was intruſted to Eugenius Dobler, a brother of the order.

Alexander's ſucceſſor, the abbot Berthold Vogel, who long reſided at Salzburg as profeſſor of canon law and rector of the univerſity, being well acquainted with Fixlmillner's great

great knowledge, particularly in the mathematics, appointed him in 1762 to be aſtronomer at Kremsmunſter, with leave to retain his office as profeſſor of canon law. He now applied with great zeal to render himſelf more fit for his new occupation, as he had not yet attended much to practical aſtronomy, and was even but little acquainted with thoſe books from which he could obtain information on the ſubject. His great attachment, however, to this ſcience, fine genius, and a deſire of being uſeful to the inſtitution in which he reſided, and to the world, made him overcome every difficulty. The firſt book that fell into his hands was Lalande's *Expoſition du Calcul Aſtronomique*, with which alone, without any oral inſtruction, he began to ſtudy and to make obſervations. This work, together with Vlacq's logarithmic tables, were for a long time his only ſources and guides, till he at length obtained Lalande's large work on aſtronomy. Fortunately, a carpenter, named John Illinger, born in a village belonging to the abbey, though he could neither read nor write, was able, under the direction of Fixlmillner, to conſtruct for him very neat mural quadrants, zenith ſectors, tranſit inſtruments, and pendulum clocks. Other inſtruments were made for him by Brander of Augſburgh, and he procured achromatic teleſcopes from Dollond; ſo that by his activity the obſervatory at Kremsmunſter ſoon became one of the moſt celebrated, and beſt ſupplied with apparatuſes, in Germany. His principal aſſiſtants were Theod. Derfflinger, who afterwards became his ſucceſſor, and Father B. Waller.

Fixlmillner now acquired a conſiderable rank among aſtronomical writers. In 1765 he publiſhed his *Meridianus Speculæ Aſtron. Cremifanenſis*, in which he eſtabliſhed the firſt elements of his obſervatory, and determined its longitude and latitude. In 1776 he publiſhed his ſecond aſtronomical work, called *Decennium Aſtronomicum*, which contained the obſervations made by him at Kremsmunſter from 1765 to 1775, and which is replete with important and uſeful information. His third work, on which he was employed towards the cloſe of his life, and which was printed after his death, appeared in 179 . It contains a valuable collection of obſervations made between the years 1776 and 1791, together with a great many calculations and treatiſes, which ſtill add to his celebrity in this department. Beſides theſe, many important articles written by him are to be found in the *Journal des Savans*; Bernoulli's Epiſtolary Correſpondence; the French *Ephemerides des Move*; the Aſtronomical Almanac of Berlin; the Aſtronomical Ephemerides of Vienna; and the Memoirs of the Royal Academy of Sciences at Paris.

The important ſervice rendered to the ſcience of aſtronomy by Fixlmillner is well known to all aſtronomers. The great number of his obſervations of Mercury, at a time when they were rare, and difficult to be made, enabled Lalande to complete his accurate tables of that planet, for which the French aſtronomer publicly returned him thanks. Fixlmillner was one of the firſt aſtronomers who obſerved the orbit of the newly diſcovered planet Uranus. He was alſo the firſt who ſupported Bode's conjecture, that the ſtar 34, in the Bull, obſerved by Flamſtead in the year 1690, and which afterwards diſappeared, was the new planet. Fixlmillner was a man of ſo great application and activity that he not only made obſervations, but calculated them all himſelf, and deduced from them the neceſſary reſults. All his obſervations, of whatever kind, he calculated on the ſpot; and to avoid errors he always calculated them a ſecond time. To uncommon induſtry he united great penetration and deep reflection, as is proved by the great many excellent remarks and diſcoveries to be found in his works. It muſt here be added, that this able aſtronomer lived in a remote part of the country, at a diſtance from all literary helps, and from others who purſued the ſame ſtudies; that is to ſay, from all thoſe things which could animate his zeal; and yet he continued, till the laſt day of his life, a ſingular inſtance of perſeverance and attachment to his favourite ſtudy. But few men were ſo little ſubject to the imperious power of the paſſions. Simple in his manners, he poſſeſſed great equanimity and firmneſs, like the immutable laws of nature which he ſtudied. His wide extended celebrity did not render him proud: whatever was written or ſaid in his praiſe, he endeavoured rather to conceal than to publiſh. His cloſe application at length impaired his health, and brought on obſtinate obſtructions, which ended in a diarrhœa. He died on the 27th of Auguſt 1791, in the 71ſt year of his age, the 53d of his reſidence in the convent, and the 46th after his entering into the prieſthood.

XXXIX. *A brief Account of the Origin and Progreſs of Letter-preſs-plate or Stereotype Printing.*

HAD I liſtened to the ſolicitations of friends, I ſhould long before this time have publiſhed ſome account of an art to the advancement of which I had in ſome degree contributed, and in which, I may affirm, I was tolerably proficient upwards of twenty years ago: I might add, that the idea

idea was truly my own—for ſuch was the fact—but in perfecting the invention I had the aſſiſtance and joint labour of another. At the time of the diſcovery I flattered myſelf that we were original; and, with thoſe ſanguine ideas which are natural to a young man, indulged the hopes of reaping ſome fame at leaſt from the diſcovery: nay, I was even weak enough to feel vexed when I afterwards found that we had been anticipated by a Mr. Ged, of Edinburgh, who had printed books from letter-preſs plates about *fifty years before!* The knowledge of this fact leſſened the value of the diſcovery ſo much in my eſtimation, that I felt but little anxiety to be known as a ſecond inventor; and but for the perſevering attempts of others to deprive Ged of the fame his memory ſo juſtly merits, and which he dearly earned, I might have ſtill remained ſilent.

It is not my intention at preſent to enter into a detail of particulars reſpecting the proceſſes connected with letter-preſs-plate or ſtereotype printing, nor would it be proper without previouſly obtaining the concurrence of Mr. Foulis, the gentleman who aſſiſted me in my labours. Much leſs is it my intention to enter into a hiſtory of printing in general: a few remarks, however, reſpecting its varieties may not prove unacceptable to ſome readers.

Impreſſing forms or images upon various ſubſtances, as clay and metals, by means of ſeals, ſtamps, dyes, punches, and the like, muſt have been an early invention: antique coins, antient bricks with inſcriptions on them, &c. are proofs of this. In this caſe, the body to be impreſſed muſt be in a ſtate comparatively ſoft and plaſtic, and the ſeal or other ſtamp is applied with ſuch a force as to make it leave its image IN *the ſubſtance* of the clay or metal. The tranſition from this to printing, which, in its ſimpleſt form, conſiſts in ſmearing over or daubing the prominences of a ſtamp with any coloured ſubſtance, that when applied to another body it may leave its impreſſion ON *the ſurface* of ſuch body, appears ſo ſimple, ſo eaſy, and natural, that it has been a matter of much wonder to the moderns that it ſhould not have been diſcovered for ſo many ages; not, indeed, till within theſe few centuries. This obſervation, however, does not apply with all its force to the Aſiatics; for in China the period of the diſcovery is ſo remote as to baffle any attempt that might be made to fix the æra of printing from blocks in that country.

Printing from blocks may be conſidered as the firſt ſpecies of printing properly ſo called. The end intended by this proceſs is obtained by cutting, upon a flat block of wood or metal, but commonly the former, the words or ſentences in-

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tended to be multiplied by printing; and the cutting is managed in such a manner, that the letters are left prominent, and present the original surface of the block, while every other part of the surface is cut down so much lower, that the paper, linen, or other material to be printed, when applied to the block or *vice versâ*, can come in contact with no part of the bottom of the incisions, but only with the projecting places which present the letters. The block being provided, its surface is either applied to another flat surface covered over with a coloured composition, as is the practice with calico printers, by which means it receives a sufficient charge to enable it to give off a portion of the colour, and, with the colour, its own form to the stuff to which it may then be applied; or the colour is diffused over its surface by means of a ball, commonly made of soft skin stuffed with wool, as is the practice with book-printers, in which case the coloured body gets the name of *printing ink*, and the paper receives the impression by being applied to, and pressed upon, the block. Were the block applied to the paper, the effect would be the same; but in practice it is found much more convenient to apply the paper to the block, for one reason among others—the paper is the lightest, and the easiest taken up in the hand.

This kind of printing, from the best information that can be collected, appears to have been applied to the manufacture of playing cards long before any idea was entertained of multiplying copies of books by its means. These cards had various kinds of figures upon them; and among others, we may observe in passing, one called the *devil*; and hence, probably, the antipathy expressed by many against all games with cards; and hence, too, may have come the opprobrious name given to them of *the devil's book*.

At length the idea of copying MSS. by means of blocks was taken up in Europe in the fifteenth century, and several books were soon executed in that manner, which may be called the first specimens of European stereotype. It was a wonderful help to the propagation of truth; and the facility with which books could be thus multiplied, compared with the trouble of writing them, would have left little cause for wonder, had it induced men to be satisfied for a long time with this first step in typography.

This method, however, continued but a short time in practice till it suggested another. Cutting or engraving a block for every page, was a work accompanied with considerable labour and expense: to cut separate letters on small pieces of wood, which might be arranged afterwards in any manner wanted,

wanted, appeared to be a likely way of ſtill further reducing the price of *book-making*, as the ſame types might be afterwards employed for different works.

This advance in the art was alſo ſoon obtained, but ſtill printers were not ſatisfied. A great number of each particular letter was required to enable them to ſet up or compoſe (as putting the letters together is called) a ſingle ſheet of any work; each letter was to be cut and adjuſted with ſuch accuracy, as to make it ſtand exactly to the ſame height of every other letter; and all ſo as to range well with each other. If the cutting of *a ſingle alphabet* could be made to anſwer inſtead of ſo many, what a ſaving of labour! Can we wonder that the attempt was made? It ſucceeded, and gave riſe to a new art, that of the type-founder, as practiſed at this day.

In this art, the letters are firſt cut upon ſteel punches: theſe are afterwards hardened, that they may bear ſtriking into pieces of copper, in which they leave their impreſſion, which pieces, called *matrixes*, being furniſhed with a proper apparatus for forming the ſtalk or ſhank of the type, ſerve as moulds, from which any number of types may be caſt, every one exactly like its original punch.

Thus we ſee that book printing has been, in its progreſs, connected with arts very different in themſelves. At its firſt origin the blockcutter was the principal agent in producing the copy of the MS. Preſſmen were alſo neceſſary. In its next ſtep, the block-cutter turns letter-cutter, each like each other in height and body, that they might range properly in lines; a labour ſo prodigious that words cannot convey any idea of the mechanical patience it muſt have required! Another ſet of workmen now became neceſſary, a new buſineſs was formed, that of the compoſitor; the perſon who arranges the letters into words, lines, and pages. The third ſtage of the art was that in which moveable metallic types were employed, which embraces the arts of the punch-cutter, the ſinker and adjuſter of the matrixes, the mould-maker, (the mould, properly ſpeaking, is that part of the apparatus which forms the ſhank or body of the type; the letter formed by the matrix is called the *face*;) the type-founder, the compoſitor, and the preſſman.

This kind of printing is called *letter-preſs*, to diſtinguiſh it from another, which is radically different both in the mode of its production and in that of its working—we mean copperplate work.

Engraving on metals is an art of great antiquity. Almoſt every kind of antient armour that has yet been found, as alſo many antique houſehold implements, are embelliſhed with engravings of leſs or more merit. We ſpeak not now of

ſculptures

ſculptures and carvings in metal, which are probably equally antient, but of engraving, properly ſo called, figures of flowers, animals, men, formed on ſurfaces more or leſs uniform, by inciſions or lines cut into them with graving tools. But though the origin of this art is ſo remote that it cannot be determined, that of taking impreſſions, or printing from ſuch engravings, appears to have been diſcovered ſubſequent to the art of letter-preſs printing. It is performed by rubbing over the plate with printing ink, and then cleaning its ſurface in ſuch a manner that the ink may ſtill remain in the inciſions. Moiſtened paper is then laid upon the plate, and both are paſſed through between rollers, with a piece of blanket or ſoft cloth on the back of the paper, which forces the latter into the inciſions, and brings it into contact with the ink left in them, a portion of which adhering to the paper, gives to it the forms engraved on the copper. This kind of printing, from the manner in which the impreſſion is obtained, is called *rolling-preſs*, and ſometimes *copper-plate printing*.

By the progreſſive ſteps which we have endeavoured briefly to enumerate, typography was brought to that ſtate of perfection to which it has attained. It is a curious fact, however, that all the improvements followed each other in ſuch quick ſucceſſion, that in a few years from its firſt invention in Europe, we find the printers in poſſeſſion of all our common modes of working, and producing ſpecimens of their art, which even now cannot be ſurpaſſed. Some of the early printed miſſals upon vellum are proofs of this.

But if we have reaſon to be ſurpriſed at the quick ſteps by which printing with moveable types was perfected, we have more cauſe to wonder why with the acquiſition of moveable types the art became ſtationary. The tranſition from ſolid pages, *cut at an expenſe and labour beyond the value of the intereſt of any capital that could be required to be ſunk in printing an edition of any work*, made it a deſirable object to deviſe means for making *the ſame letters* do over and over, not only for different ſheets in ſucceſſion of the ſame work, but for ſubſequent publications. Hence came the firſt moveable types; which, however, as we have already obſerved, were all *cut* ſingly. The ſucceſs which followed the attempts made to leſſen this labour of *cutting*, by making well formed letters *once cut* ſerve for ever, by the facility of multiplication which founding afforded, ought, one would think, inſtantly to have led to a further improvement. If founding could be applied to ſingle letters, *why not to pages*, to get rid of a ſacrifice of capital ſubmitted to at firſt, becauſe of

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the enormous expense of block cutting! Founding of pages, on the first view of it, promises many advantages in point of economy; and to science it holds out what can never otherwise be obtained—the possibility of procuring in a short time *immaculate editions*. From books cast into solid pages, no more copies would be printed than might be wanted for immediate sale; the money thus saved from being sunk in paper, to be piled up in warehouses for years, as at present, would serve as surplus capital to print other works; and thus the printer, his workmen, and the booksellers, would all be benefited; (for it would be easy to prove, did our present limits allow it, that not only the business of the pressmen, but of the compositors, would be materially benefited and increased by the general adoption of such an improvement) and all errors as soon as discovered could be rectified in the plates, to prevent them from appearing in after copies, instead of running through a large edition as at present.

Such considerations as I have just stated first led me to turn my thoughts to the improvement of the art of printing; and the more I thought upon it, the more I became convinced of its practicability. I communicated my ideas upon the subject to Mr. Foulis, printer to the university of Glasgow, my native city, and where I then resided, who furnished me with a page of types ready set up, or composed, for my first experiment, which had sufficient success to induce me to try others, and convinced Mr. Foulis of the possibility of producing plates, which would yield impressions not to be distinguished from those taken from types.

If I had seen some of the advantages which such a plan promised, Mr. Foulis saw and pointed out many more, of such a nature as could only present themselves to a regular bred practical printer. We agreed to prosecute the business together, and, if possible, to bring it to perfection, and in pursuance of this resolution performed, I may say, innumerable experiments, till we at last overcame every difficulty, and were able to produce plates, the impressions from which could not be distinguished from those taken from the types from which they were cast.

In the mean time we learnt that our art, or one extremely similar, had been practised many years before by Mr. GED, as I have before observed; and soon after the world was favoured, by Mr. NICHOLLS, with an interesting pamphlet entitled "Biographical Memoirs of William Ged; including a particular account of his progress in the art of block printing*." The first part of the pamphlet, as the editor informs

* London: printed by and for J. Nicholls, MDCCLXXXI.

informs us, was printed from a MS. dictated by Ged ſome time before his death: the ſecond part was written by his daughter, for whoſe benefit the profits of the publication were intended: the third was a copy of propoſals that had been publiſhed byMr GED's ſon in 1751, for reviving his father's art; and to the whole was added Mr. MORES's narrative of block printing.

From this publication it appears, that ſo far back as the year 1725 Mr. Ged had begun to proſecute plate-making. In 1727 he entered into a contract with a perſon who had a little capital, but who on converſing with ſome printer got ſo intimidated that at the end of two years he had laid out only 22l. In 1729 he entered into a new contract with a Mr. Fenner, Thomas James a type-founder, and John James the architect; and ſome time after a privilege was obtained fron the univerſity of Cambridge to print bibles and prayer-books. But it appears that one of his partners was actually averſe to the ſucceſs of the plan, and engaged ſuch people for the work as he thought moſt likely to ſpoil it. A ſtraggling workman who had wrought there informed Mr. Mores "that both bibles and common prayer-books had been printed, but that the compoſitors when they corrected one fault made purpoſely half a dozen more, and the preſſmen when the maſters were abſent battered the letter in aid of the compoſitors. In conſequence of theſe baſe proceedings, the books were ſuppreſſed by authority, and the plates ſent to the King's printing-houſe, and from thence to Mr. Caſlon's foundery."

After much ill uſage, GED, who appears to have been a perſon of great honeſty and ſimplicity, returned to Edinburgh. His friends were anxious that a ſpecimen of his art ſhould be publiſhed, which was at laſt done by ſubſcription. His ſon, James Ged, who had been apprenticed to a printer, with the conſent of his maſter ſet up the forms in the night-time, when the other compoſitors were gone, for his father to caſt the plates from; by which means Saluſt was finiſhed in 1736. Of this work I have a copy, and, which is more ſingular, the plate of one of the pages; and from it the ſpecimen of Ged's work given with the preſent article was printed. This plate I firſt ſaw in the hands of the deceaſed Mr. John Murray, bookſeller, in the year 1782, but do not now recollect the way in which he ſaid it came into his poſſeſſion. Having about a year ago applied to his ſucceſſors in buſineſs, Meſſrs. Murray and Highley, to requeſt, if the plate could be found, that I might be allowed to take ſome impreſſions from it; they very politely inſiſted on my acceptance of what

they had used for years as a flat weight to lay upon papers on the end of the desk. After what I have just stated, I need hardly add that the plate has received considerable injury, and that it would be unfair to judge by its present appearance of the degree of perfection to which Ged had brought the art. It is extremely probable too, that the forms from which he made his moulds were composed of worn types, which will always produce plates that may be said to be worn before they are used.

Besides the Salust, I have another work printed some years after from plates of Mr. Ged's manufacture. The book is "*The Life of* GOD *in the Soul of Man*," printed on a writing pot, 12mo, and with the following imprint: "NEWCASTLE: *Printed and sold by* JOHN WHITE, *from plates made by* WILLIAM GED, *Goldsmith in Edinburgh*, MDCCXLII." It is a very neat little volume, and is as well printed as books generally were at the time.

Though we had reason to fear from what we found Ged had met with, that our efforts would experience a similar opposition from prejudice and ignorance, we persevered in our object for a considerable time, and at last resolved to take out patents for England and Scotland, to secure to ourselves, for the usual term, the benefits of our invention; for the discovery was still as much our own as if nothing similar had been practised before; Ged's knowledge of the art having died with his son, whose proposals for reviving it, published in 1751, not having been followed with success, he went to Jamaica, where he died. The patents were accordingly obtained; nay, they are even expired: and yet we hear people, who only began their stereotype labours *yesterday*, taking to themselves the merit of being the first inventors!—As to *benefits*, however, I have as yet reaped none, and Mr. Foulis I believe has reaped as few; for, owing to circumstances of a private nature, and which no way concern the public to know, the business was laid aside for a time; and having afterwards quitted Glasgow and removed to London, I soon found myself so much occupied with other concerns, that I have hardly had time even to think upon it since. I ought however to observe here, that its being suspended was not on account of any imperfection attending the art, or objections against its being a fit object to be prosecuted. On the contrary, several small volumes were actually printed from plates made by myself and Mr. Foulis, and the editions were sold to the trade without any intimation of their being printed out of the common way! We had heard whispers that our work could not possibly be such as would pass for *com-*

mon

mon printing! The trade knew what we were at, and would *take care* of any thing done in the *new-fangled* way! The first essays, therefore, were in the lowest sense of the word common: one or two *histories**, and a cheap edition of The Economy of Human Life. We also printed a Greek volume, *Xenophon's Anabasis*, 1783, and had plates for several small volumes of the English Poets almost finished, but the latter were never put to press. Having preserved two or three of the plates made along with Mr. Foulis, I shall subjoin to the present account a specimen of one or two. They have been damaged by lying about for a number of years, and by a carriage of 400 miles; yet I shall offer no apology for their appearance.

Twice then had this art been invented and practised in Britain, when about three years ago DIDOT, the celebrated French printer, applied it to logarithmic tables, and afterwards to several of the Latin classics, and to various French publications, which he has executed with considerable accuracy. The press-work has been carefully attended to, and does great credit to the printer. Indeed, after what Didot has done, clamour and prejudice will attempt in vain in future to decry letter-press-plate, and his name will always be mentioned as a principal promoter of this useful art, the introduction of which will be marked as a singular æra in the history of printing. Some of his countrymen indeed (for I cannot suppose Didot would attempt it) wish to ascribe to him the whole merit of the invention, and to have it believed that it originated with himself. The facts I have stated show with how little justice this claim is made. It is true he may have discovered, for himself, the secret of the art; but it is hardly credible that he could be ignorant of Ged's progress and of ours, especially as it is well known that, when patents are obtained, a specification of the process is obliged to be put upon record, of which any one may obtain an office copy at a small expense.

Having stated what relates immediately to the invention of modern Stereotype, it would not be ingenuous were I not to state that claims have been set up in favour of a Dutchman as having practised the art even prior to Ged. The following extract, translated from *Nieuw Algemein Konst en Letter Bode* 1798, No. 232, will put our readers in possession of all we have yet met with respecting this printer.

* A kind of books technically so called, such as *The Seven Champions of Christendom*; *The Twelve Cæsars*; *The History of Valentine and Orson*; *The French Convert*; and such scientific and classical performances, of which great numbers are annually exported to America.

"Above a hundred years ago, the Dutch were in poſſeſſion of the art of printing with ſolid or fixed types, which in every reſpect was ſuperior to that of Didot's ſtereotype. It may, however, be readily comprehended that theſe letters were not cut in ſo elegant a manner, eſpecially when we reflect on the progreſs which typography has made ſince that period. Samuel and J. Leuchtmans, bookſellers at Leyden *, have ſtill in their poſſeſſion the forms of a quarto Bible which were conſtructed in this ingenious manner. Many thouſand impreſſions were thrown off, which are in every body's hands, and the letters are ſtill good.

"The inventor of this uſeful art was J. Van der Mey, father of the well-known painter of that name. About the end of the 16th century he reſided at Leyden. With the aſſiſtance of Muller, the clergyman of the German congregation there, who carefully ſuperintended the correction, he prepared and caſt the plates for the above-mentioned quarto Bible. This Bible he publiſhed alſo in folio, with large margins ornamented with figures, the forms of which are ſtill in the hands of Elwe, bookſeller at Amſterdam *: alſo an Engliſh New Teſtament, and Schaaf's Syriac Dictionary, the forms of which were melted down; and likewiſe a ſmall Greek Teſtament in 18mo.

"As far as is known, Van der May printed nothing elſe in this manner; and the art of preparing ſolid blocks was loſt at his death, or, at leaſt, was not afterwards employed. The cauſe may readily be conceived; for, though this proceſs in itſelf is very advantageous, it is far more expenſive than the uſual method of printing, except in thoſe caſes when ſuch works are to be printed as are indiſpenſably neceſſary, and of ſtanding worth. The number of theſe, however, is certainly ſmall; eſpecially as we are acquainted with no inſtance in the annals of Dutch printing, that any dependance can be placed on the ſale of 150,000 copies, as was the caſe with the brothers Guyot."

The publiſher of the preceding notice ſuppoſes, nay, aſſerts, that the expenſe of ſtereotype precludes its uſe, ex-

* Should the preſent article chance to meet the eyes of Meſſrs. Leuchtmans or Elwe, the gentlemen mentioned in this extract as being poſſeſſed of ſome of Van der May's forms, they would confer a perſonal favour on the author of the preſent article, and at the ſame time a ſervice to truth, if they would have the goodneſs to part with the plates or blocks of a few pages, and forward them to his addreſs in London by any of the veſſels which bear his Pruſſian majeſty's flag, and which are daily paſſing between the two countries. By inſpecting them, he thinks he could determine whether Van der May's proceſs was the ſame that he himſelf has practiſed.

cept

cept in the caſe of ſtandard authors, whoſe works are ſure of an extenſive ſale: but, unhappily for his mode of reaſoning, exactly the converſe of this is the truth; for, if there would be an advantage in applying the ſtereotype art to books of rapid ſale, there would be a ſtill greater one in the caſe of thoſe publications whoſe ſale may be leſs certain, as at the worſt there could only be the loſs of the plates, in place of that of the paper and preſswork of a whole edition, which, in almoſt every caſe, would amount to a much larger ſum. The expenſe, then, attending the proceſs (if, indeed, Van der May's was the ſame as ours) was not the cauſe of its being laid aſide in Holland. The probability is, that his art died with himſelf; for we find that Ged had "offers from Holland, repeatedly, either to go over there, or ſell them his invention *;" which would not have been the caſe had they been poſſeſſed of their own countryman's. A. T.

XL. *Communication from Profeſſor* M. A. PICTET, *of Geneva, (now in London,) on Flexible Stones, addreſſed to the Editor.*

SIR,

Brompton Row, No. 45,
Auguſt 20, 1801.

IN reading lately in your very intereſting Journal (Vol. X. p. 83.) a deſcription of the *elaſtic quartz*, or *flexible ſandſtone*, from Brazil, I wondered that the author † had not mentioned a ſimilar phænomenon which has been obſerved in another ſtony ſubſtance, commonly as inflexible as any ſiliceous aggregate, but thoroughly different in point of chemical compoſition—I mean the table of *elaſtic marble*, which is ſhown at Rome as a great curioſity. A friend of mine, M. Fleuriau de Bellevue, from La Rochelle, who had ſeen it, gueſſed at the cauſe of its flexibility, and went ſo far as to render, by a particular proceſs, any given ſpecimen of Carrara marble as evidently flexible as the table in queſtion. He purſued at Geneva the ſeries of experiments which led him to that diſcovery, and read to our Society of Phyſics and Natural Hiſtory an account of the whole, which has been ſince publiſhed in La Metherie's *Journal de Phyſique*. The following are the leading facts:

That ſpecies of marble conſiſts, as you well know, in a confuſed aggregation of ſmall irregular cryſtals interwoven

* Biographical Memoirs of W. Ged, p. 16.
† Klaproth.

in all poſſible directions, and adhering to one another by a certain degree of coheſive force. He thought that if he could, by any proceſs, deſtroy that adherence, without altering much the ſolidity of the cryſtals themſelves, he might thus obtain a looſe, but entire, ſtony aggregate, which would become flexible on account of the relative mobility of the integrant cryſtals, but keep its ſolidity and preſerve its form in conſequence of their being deeply implicated and interwoven among themſelves.

According to that theory, he undertook a ſeries of experiments by expoſing ſlips of marble to the action of fire in ſand-baths of regularly graduated and well aſcertained temperatures: he thus found a point where the adheſion of the cryſtals was looſened, without any material alteration in their hardneſs. He gave to his friends ſome ſpecimens of Carrara marble thus rendered flexible. I have one of them in my poſſeſſion here in London, which may be ſeen by any perſon who ſhould yet entertain any doubts as to the poſſibility of the fact.

Now, a volcanic fire may have acted on a large maſs of marble nearly as my friend's furnace has done on his ſmall ſpecimens; and this explanation of the natural phænomenon I conſider as being as near to truth as moſt of our conjectures on ſimilar ſubjects can be.

I am, Sir, with true regard,
Your moſt obedient humble Servant,

Mr. Tilloch. M. A. PICTET, F.R.S. Lond. et Edinb.

XLI. *On the Velocity of Water Wheels. By Mr.* ROBERTSON BUCHANAN, *Engineer. Communicated in a Letter to the Editor.*

DEAR SIR, London, No. 75, Piccadilly, 14th Auguſt, 1801.

THE accompanying paper was read in May 1799, in a Philoſophical Society at Edinburgh. I offer it to you with diffidence, knowing that it contains things contrary to received opinions. Having, however, made no wilful error, if you think proper to publiſh it in your Magazine, it may induce thoſe who have leiſure and abilities to enter more fully into the inveſtigation of the ſubject.

I am, dear Sir,
Your very humble Servant,

Mr. Tilloch. ROBERTSON BUCHANAN.

THERE are many cafes in which it is of importance to know the proportion of power neceſſary to give different degrees of velocity to a mill *. But as the conſtruction of mills, and the purpoſes they ſerve, are various, it is perhaps impoſſible to find any law of univerſal application. Mr. Banks, in his Treatiſe on Mills †, has drawn a concluſion, which he appears to conſider as invariable, namely, that "when a wheel acts by gravity, its velocity will be as the cube root of the quantity of water it receives."

But if we ſuppoſe a wheel raiſing water, by means of cranks and pumps, on Mr. Banks's principle, it might eaſily, I think, be demonſtrated, that, by reducing the velocity of the wheel to a certain degree, the wheel would raiſe more water than would be neceſſary to move it at that velocity; a thing evidently impoſſible.

In this view, it would ſeem there is no actual caſe in which Mr. Banks's concluſions will hold true. But, however they may apply to other mills, the experiments which I am going to mention ſeem to me to prove, at leaſt, that they do not apply to cotton mills. On the ground of theſe experiments, made at different times, and with all the attention in my power, (and not from any abſtract conſideration,) have I preſumed to call in queſtion an authority for which I entertain the higheſt reſpect.

In January 1796 I meaſured the quantity of water the old Rotheſay cotton mill required, 1ſt, when going at its common velocity; and, 2dly, when going at half that velocity. The reſult was, that the laſt required juſt half the quantity of water which the firſt did. It is to be obſerved, that in theſe experiments the quantities of water were calculated from the heads of water and apertures of the ſluices.

From theſe experiments I inferred, "that the quantity of water neceſſary to be employed in giving different degrees of velocity to a cotton mill, muſt be nearly as that velocity."

I was ſatisfied with this experiment, and the inference I drew from it, till ſome gentlemen, well acquainted with the theory and practice of mechanics, expreſſed their doubts on the ſubject. I had then recourſe to another experiment, which I conſidered as leſs liable to error than the former.

The water which drives the old cotton-mill falls, a little below it, into a perpendicular-ſided pond, which ſerves as a dam for a corn-mill. To aſcertain, therefore, the propor-

* It was a ſcarcity of water for the Rotheſay mills which directed my attention particularly to this ſubject.

† See Banks on Mills, p. 17, 18. 144, 145, 146.

tional quantities of water uſed by the old mill, nothing more was neceſſary than to meaſure the time the water took to riſe to a certain height in that pond; and accordingly, on the firſt of May 1798, I made the experiments noted in the following table:

1	2	3	4	Number of experiments.
46	46	24	23	Revolutions of one of the upright ſhafts per minute.
5	5	5	5	Riſe of water in the pond in inches.
6.58	6.57	14.45	15.0	Time in minutes and ſeconds.

The firſt and ſecond experiments were made with the mill at its common velocity; the third and fourth at nearly half that velocity.

The time which the mill required to uſe the ſame quantity of water in theſe experiments may be taken in round numbers; the proper velocity at 7 minutes, and half that velocity at 15 minutes.

The reſult of theſe experiments approaches very nearly to that of 1796. The difference may be accounted for by the ſmall degree of leakage which muſt have taken place at the ſluices on the lower end of the pond; and the time being greater in the third and fourth experiments, the leakage would, of courſe, be greater.

Mr. Smeaton * and others have proved, in a very ſatisfactory manner, that "the mechanical power which muſt be employed in giving different degrees of velocity to the ſame body muſt be as the ſquare of that velocity" But it appears to me that the reſult of the above experiments may be eaſily reconciled to this propoſition by conſidering what Mr. Smeaton ſays immediately afterwards:—"If the converſe of this propoſition (ſays he) did not hold true, viz. that if a body in motion, on being ſtopped, would not produce a mechanical effect equal or proportional to the ſquare of its velocity, or to the mechanical power employed in producing it, the effect would not correſpond with its producing cauſe." Now, it is to be obſerved, that Mr. Smeaton's experiments were made on the *velocity* of heavy bodies *free from friction* and

* See Smeaton on Mills, p. 18.

other

other cauſes of reſiſtance; but in mills there is not only friction, but obſtacles to be removed: and experiments made on friction have proved that the frictions of many kinds of bodies increaſe in direct proportion to their velocity. But the velocity of a cotton-mill at work may be conſidered as a mechanical effect, and, if ſo, muſt correſpond with its producing cauſe.

XLII. *Account of a new Inſtrument for the Extraction of Teeth, by the Inventor, Mr.* REECE, *Member of the Royal College of Surgeons, London.*

SIR, Craven-Street, Strand, Aug. 15, 1801.

IN the firſt Number of the ſecond Volume of your very uſeful Publication is an account of an inſtrument for the extraction of teeth, which the inventor (a Mr. Brown) repreſents as a *very great improvement* of the German key inſtruments. This *great improvement* conſiſts in a depreſſion on the front of the fulcrum, which (as he obſerves) "forms a bed to receive the tooth." The experiments of Mr. Brown, I am well informed, were made on an old jaw of a ſkeleton, the alveolar proceſs of which being imperfect, the application of the concaved fulcrum to the convexity of the tooth was eaſily admitted; and, no doubt, its extraction effected "without much violence to the jaw, or pain to the patient." But in the *living ſubject*, the alveolar proceſs and contiguous ſoft parts being interpoſed between the *concaved* fulcrum and the tooth, the *great advantages* derived from this *invention* are, an unavoidable laceration and contuſion of the gum, and great violence to the jaw-bone and ſocket, producing troubleſome inflammation and often alarming hemorrhagies, from there being no correſponding eminence of the gum, on which it reſts, to fill up the hollow (the bed) of the fulcrum: the corners, by the preſſure neceſſary for the expulſion of the tooth (which, when firm, is very conſiderable) are productive of very ſerious miſchief; and thoſe practitioners who were induced to give theſe inſtruments a trial, experiencing their bad effects, have returned them to the maker.

Similar effects (however, in a much leſs degree) too often ariſe from the preſſure of the heel of the inſtrument in common uſe, and the oblique direction in which the tooth is extracted; to obviate which I have invented an inſtrument which, by the peculiar curvature of the claw, elevates the tooth in nearly a per-

a perpendicular direction, and from the ſtructure of the fulcrum, the preſſure, not falling on the gum till the tooth is a little raiſed, is very trifling for its complete expulſion, by which means the injury of the jaw-bone and contuſion of contiguous ſoft parts are avoided, and, conſequently, the moſt painful part of the operation. The ſurrounding gum being previouſly ſeparated by the ſcarificator (which accompanies it) from the tooth, that the claw of the inſtrument may be applied as low down as the alveolar proceſs will admit of, the upper part of the fulcrum will, on turning the inſtrument, apply itſelf exactly oppoſite to the end of the claw; the operation is afterwards performed with the greateſt facility, and my patients have uniformly expreſſed their ſurpriſe at the ſlight pain they experienced. As the inſtrument may be ſeen at Mr. Whitford's, ſurgical inſtrument maker, St. Bartholomew's Hoſpital, who is fully competent to give every information reſpecting it, I judge any further delineation of it here unneceſſary.

Should the inſtrument I now recommend to the attention of my profeſſional brethren meet with their ſupport by the reſult of practice, I ſhall be amply rewarded for my trouble by the honour of their approbation.

I am, Sir,

Your very obedient Servant,

To Mr. Tilloch. RICHARD REECE.

XLIII. *Account of New Publications, &c.*

I. *An Account of Travels into the Interior of Southern Africa, in the Years* 1797 *and* 1798: *including curſory Obſervations on the Geology and Geography of the Southern Part of that Continent; the Natural Hiſtory of ſuch Objects as occurred in the Animal, Vegetable, and Mineral Kingdoms; and Sketches of the Phyſical and Moral Characters of the various Tribes of Inhabitants ſurrounding the Settlement of the Cape of Good Hope. To which is annexed a Deſcription of the preſent State, Population and Produce of that extenſive Colony; with a Map conſtructed entirely from actual Obſervations made in the Courſe of the Travels. By* JOHN BARROW, *late Secretary to the Earl of Macartney, and Auditor-General of the Public Accounts, at the Cape of Good Hope.* 4*to.* CADELL *and* DAVIES.

THE nature and deſign of this publication are ſo fully expreſſed in the title as to leave us nothing to add on theſe points.

points. The work is executed in a maſterly manner, and contains much new and uſeful information in the various branches which it embraces. Naturaliſts in particular will be highly gratified, while readers of every deſcription will receive from it much amuſement and inſtruction. The account of the Table and Paarlberg Mountains, given in the preceding pages, is an extract from this work, and may ſerve as a ſpecimen of the author's ſtyle, which is neat and perſpicuous.

II. PIEN-HOE-YE, *The Explanation of the elementary Characters of the Chineſe, with an Analyſis of their ancient Symbols and Hieroglyphics. By* J. HAGER, D. D. *Fol.* Phillips, St. Paul's Church-Yard.

THIS work is the commencement of a great enterpriſe which Dr. Hager propoſes to undertake, viz. a Chineſe Dictionary, and for which he has been collecting materials. As want of room will not permit us to give an analyſis of it, we muſt be contented with obſerving, that after a preliminary diſcourſe which diſplays much ingenuity and learning, the author proceeds to explain the elementary characters or keys, which are in number two hundred and forty, and of which a dictionary is given. Each compound character contains one of theſe two hundred and forty elementary characters, which ſerves it as a baſe. The order in which the elementary characters is placed, is determined by the number of pencil-ſtrokes of which they are formed; they are divided into ſeventeen claſſes, the firſt of which is formed of one, and the laſt of ſeventeen, pencil-ſtrokes. Thus, when we wiſh to find an elementary character in the dictionary, we muſt obſerve of how many pencil-ſtrokes it is formed, and this will be ſufficient to aſcertain the principal claſs to which it belongs; the place which it occupies in this claſs is merely arbitrary. The ſame operation will ſerve for finding a compound character; we muſt firſt ſeek for the elementary character, which ſerves it as a key; and when this is found, we can aſcertain without difficulty to which of the two hundred and fourteen ſecondary claſſes compoſing the dictionary it belongs. This work muſt be of great utility to thoſe who are deſirous of ſtudying the Chineſe language. A reſpectable French Journal (*Magazin Encyclopédique, Meſſidor An.* 9) ſpeaking of it ſays, "We ſincerely wiſh that Dr. Hager may meet with every encouragement to go on with the publication of this important dictionary; and we have no doubt that his name, already juſtly celebrated, will be claſſed among thoſe

of

of the literati who have greatly contributed to the glory of their age by extending the boundaries of the republic of letters."

XLIV. *Proceedings of Learned Societies.*

ROYAL ACADEMY OF SCIENCES AT COPENHAGEN.

THIS Academy has propoſed the following

Prize Queſtions.

1ſt, It is required to determine whether oxgyen or the gaſes which contain it are abſolutely neceſſary for the expanſion of chickens or other birds in the egg, or whether it be poſſible that this expanſion may take place in irreſpirable gaſes, and in what kind.

2d, What is the influence of poſitive or negative electricity on the elaſticity of the air, and its faculty of receiving water in the ſtate of gas or vapour?

The prize for each of theſe queſtions is a gold medal, of the value of a hundred Daniſh crowns. The papers muſt be tranſmitted to the ſecretary of the ſociety before the end of September 1802.

ROYAL SOCIETY OF GOTTINGEN.

The following queſtion, propoſed as the ſubject of a prize, will be decided in the month of November 1801:—

As the great difference between the oriental hiſtorians and the Greek and Roman writers, in regard to the hiſtory of the antient kingdom of Perſia, has not yet been properly elucidated, the ſociety requires that it may be critically examined, and in ſuch a manner that, neglecting the oldeſt and fabulous kings, the ſubject may be confined to the hiſtorical age after Alexander, that is, the Greek and Parthian kings, or the families of the Arſacidæ and the Saſſanidæ. The kings of theſe dynaſties, together with ſome account of their reigns, muſt be collected from the oriental writers. The ſources from which theſe derived their information muſt be examined, the chronology of theſe kings and periods muſt be compared with the Greek and Roman chronology, and the cauſes of their diſagreement muſt be examined; alſo the means of reconciling them, and which method of computation in regard to hiſtorical truth ought to be preferred.

XLV. *Intelligence and Miſcellaneous Articles. Auguſt*, 1801.

ON the 1ſt of January laſt another NEW PLANET is ſaid to have been diſcovered by M. Piazzi, of Palermo, and obſerved by *him alone* for ſix weeks, when he fell ill. It ſeems he concealed the diſcovery, to preſerve all the honour to himſelf, and to enjoy excluſively, for a time, at leaſt all the obſervations. While he obſerved it, it deſcribed an arch of about 10°.

M. Bode thinks it may be not a comet, but a planet between Mars and Jupiter; but ſays however that the arch is too ſmall to allow much confidence to be placed on the calculations of an elliptical orbit, which have been formally made by Dr. Burchardt, aſſiſtant to De Lalande, and publiſhed in Zach's journal.

Burchardt gives its place, computed from his elements for ſome time to come. It was paſt its oppoſition to the ſun, and of the ſize of a ſtar of the 8th magnitude: its mean diſtance from the ſun 2·57 times that of the earth, and the periodical time nearly four years and two months: its eccentricity ſmall; inclination of orbit between 11° and 12°. It was in its aphelion on the beginning of January.

It will ſoon be known whether theſe calculations be well founded or not, when the planet, if it be one, comes again to be viſible by withdrawing from the ſun's rays.

METEORS.

On the night of June 19th, between twelve and one, a moſt beautiful phænomenon was obſerved at Hull, from the S. W. reſembling an immenſe moon, with a black bar acroſs on its firſt appearance; it ſeemed then gradually to form itſelf into ſeven ſmall diſtinct moons, or globes of fire, which diſappeared for the ſpace of a few ſeconds. Its re-appearance was equally brilliant, at firſt ſhowing itſelf like the face of the moon, afterwards in five circular balls, and laſtly like ſeveral ſmall ſtars, which gradually faded away, leaving the whole atmoſphere beautifully illuminated. During the time of its being viſible, a faint blue light fell upon the ſurrounding objects; and when entirely gone, the ſky was ſerene, like that of a fine ſummer's morning.—*Hull Advertiſer, July* 4.

On the evening of the 14th of July, about half after nine, a remarkable meteor was ſeen at Montgaillard. The ſky was clear and the wind calm. An exhalation like a common cloud then gradually aroſe. It ſeemed of the length of 3000 fathoms,

fathoms, in breadth about 1200 or 1500, under an angle of twelve degrees. In a little it appeared to take fire. It burnt with a pale flame like that of ſpirit of wine. At the edges it exhibited a ſplendid glory. It continued for fifteen minutes. After an interval it was rekindled for eight or ten minutes more. It was then extinguiſhed, and in a moment appeared a third time, which was of very ſhort duration. It was alſo ſeen at a diſtance of about 2000 fathoms in the ſame direction, at an elevation of forty-five degrees, but with a much fainter light than at Montgaillard.

MEDICINE.

Dr. Van Deiman, of Amſterdam, has lately announced that he has employed with ſucceſs the oxygenated muriatic acid for cutaneous diſorders, ſuch as the itch and ſcald head; and he thinks this remedy preferable to all mercurial frictions. He has employed it alſo for loſs of the gums, eſpecially when the latter is occaſioned by a high degree of ſcurvy. Six ounces of roſe-water, two ounces of conſerve of roſes, and from ten to fifteen drops of oxygenated muriatic acid, employed as a waſh for the mouth, have in ſuch caſes performed wonders.

TO PRESERVE CORN IN SACKS.

Provide a reed cane, or other hollow ſtick, made ſo by glewing together two grooved ſticks; let it be about three feet nine inches long; and that it may be the eaſier thruſt down to the bottom of the corn in the ſack, its end is to be made to taper to a point, by a wooden plug that is fixed in, and ſtops the orifice. About an hundred and fifty ſmall holes, of one eighth of an inch diameter, are to be bored on all ſides of the ſtick, from its bottom for about two feet ten inches of its length; but no nearer to the ſurface of the corn, leſt too great a proportion of the air ſhould eſcape there. By winding a packthread in a ſpiral form round the ſtick, the boring of the holes may be the better regulated, ſo as to have them about half an inch diſtant towards the bottom, but gradually at wider ſtiſtances, ſo as to be an inch aſunder at the upper part; by which means the lower part of the corn will have its due proportion of freſh air. To the top of the ſtick let there be fixed a leathern pipe ten inches long; which pipe is to be diſtended by two yards of ſpiral wire coiled up within it. At the upper part of the pipe is fixed a taper wooden faſſet, into which the noſe of a common houſehold bellows is to be put, in order to ventilate the corn.

If corn, when firſt put into ſacks, be thus aired every other

or

or third day, for ten or fifteen minutes, its damp ſweat, which would hurt it, will, in a few weeks, be carried off to ſuch a degree, that it will afterwards keep ſweet with very little airing, as has been found by experience.

By the ſame means many other kinds of ſeeds, as well as corn, may be kept ſweet either in ſacks or ſmall bins.

This method muſt not be underſtood as applicable to barley; all other grain may be ſafely preſerved in this manner; but nothing can prevent a deleterious fermentation of barley, when it is once out of the ſtraw.

AGRICULTURE.

It is with extreme pleaſure we announce to the friends of agriculture, and indeed to the world at large, that the Duke of Bedford is going to eſtabliſh, at his own individual expenſe, an agricultural college at Woburn.

What are to be the particular regulations of this inſtitution, as princely as it is novel, we have not at preſent been informed; all that we yet learn is, that the Profeſſor will have the opportunity of availing himſelf of whatever is going forwards on his Grace's very extenſive farm, and of ſuperintending the various operations and experiments which now are, or will be in future, carried on there. The gentleman, whom the Duke has ſelected to fill this important office is, we underſtand, the Reverend Mr. Edmund Cartwright. His Grace's choice, the reader muſt agree with us, could not have fallen on any one more competent to a ſituation requiring not only much practical knowledge, but great variety of ſcientific attainments.

Sincerely do we congratulate the public on the eſtabliſhment of this moſt uſeful inſtitution, the firſt certainly of its kind in this country, and, we believe, in Europe. Of the REAL patriotiſm and munificence of its truly noble founder, there can be only one ſentiment.

SPANISH WOOL.

One of the prejudices which moſt ſtrongly oppoſe the propagation of ſheep with ſuperfine wool, is the opinion, too generally diffuſed, that this race cannot ſucceed in our climate and with our ordinary paſtures. The uſeful voyage that C. Laſteyrie has recently made in the north of Europe, enables us to announce, that even the exceſſive cold does not contribute to the degeneration of wool, as the Spaniſh race is preſerved pure in the moſt northern parts of Sweden and Denmark. A fact lately obſerved by C. Richard D'Aubigny even enables us to advance, that bad food and paſturage

paſturage in humid places, although they injure the health of the animals themſelves, do not impair the beauty of the wool. He had been called to particular functions elſewhere, which obliged him to abandon to the care of inferior agents the flock of the pure race kept on his own property. This flock has been, for ten years paſt, managed like all thoſe of the department of the Allier, that is to ſay, ſhut up at nights in cloſe narrow ſtables, the dung of which is only taken away once a year, and led out at days by children into the moſt marſhy paſtures, and without any precaution againſt epizootic diſeaſes. C. Richard, on returning to his farm, found his ſheep in the worſt poſſible ſtate of health, but the wool had not, by any means, degenerated; and he has preſented the Society of Agriculture ſome patterns of very fine cloth, which he has cauſed to be manufactured with this wool in many of the beſt manufactories. Citizen Teiſſier had recognized the ſame fact in an experiment which he had tried at Rambouillet. He had abandoned, for many years together, a male and female of pure race, in a meadow very moiſt and all encompaſſed with water. Thoſe animals had become completely wild; they took them in order to ſhear them with ſnares or gins, and, in ſpite of ſuch a long and untavourable reſidence, their wool and that of their progeny had not degenerated.

IMPROVED PUMP.

We ought to have mentioned in the account of Mr. Buchanan's pump, given in the preceding pages, that a model of it is lodged at the Royal Inſtitution.

MEDICAL AND CHEMICAL LECTURES.

The firſt week of October next, a Courſe of Lectures on the Materia Medica, Practice of Phyſic, and Chemiſtry, will recommence at the Laboratory, in Whitcomb-ſtreet, Leiceſter-ſquare, at the uſual morning hours, viz.—the Materia Medica at a quarter before eight; the Practice of Phyſic at half after eight, and the Chemiſtry at a quarter after nine. By George Pearſon, M. D. F. R. S. Senior Phyſician to St. George's Hoſpital, and of the College of Phyſicians. A regiſter is kept of the caſes of Dr. Pearſon's patients, in St. George's Hoſpital; and an account is given of them at a Clinical Lecture every Saturday morning, at nine o'clock. Propoſals may be had at St. George's Hoſpital, and in Leiceſter-ſquare.

XLVI. *Description of the Salt Mines of Wielitska, in Poland.* By J. Peschier, *M. D.**

THE village of Wielitska lies at the distance of two leagues to the south-west of Cracow; it is situated on the gentle declivity of a cultivated mountain, and is very populous. These valuable mines were discovered in the year 1251, and since that time they have been constantly worked; but it is only since the late changes effected in the political state of Poland that the working of them has been carried on with the present degree of spirit.

The descent into these mines is through square pits, twenty fathoms in depth and from twelve to fourteen in diameter, cut through the pure salt, if we except a few fathoms of earth by which they are covered. There are six of them, of different dimensions, distant about a hundred feet from each other, and which all communicate with each other internally.

This descent, which is attended with some novelty, in some excites fear rather than curiosity. Those who visit it are seated in a sort of chair made of ropes, and strongly attached to a thick rope, which passes round a large wheel moved by a horse, and which is thus let down into the pit. From two to ten persons may be seated around this rope, provided they hold very fast with their hands; but if they are subject to giddiness, they must then be secured by a girdle which passes round the body. It is customary before they descend to offer up a short prayer, which adds considerably to the awfulness of the preparation for the descent; but the efforts which each afterwards makes to conceal his terror on viewing the vast and obscure pit, the extremities of which they dare not consider, generally overcome every sensation of timidity, and the six minutes employed in reaching the bottom soon glide away amidst mirth and security.

When you arrive at the depth of ten fathoms you find yourself in fresh and agreeable air, and afterwards experience only very slight modifications of the temperature till you reach the bottom, the depth of which is twenty fathoms.

On reaching the bottom of the pit, a great number of the workmen flock round you offering you their services; and you then find yourself in the centre of six radii, each of which forms an extensive gallery. It is at this centre that salt dug

* From the *Journal Britannique*, published at Geneva by Professor Pictet.

from the mine is collected, and conveyed to the top of the pit by means of the ſame rope that brings down thoſe who viſit it from curioſity.

The firſt remarkable object that occurs is a magnificent altar, of moderate dimenſions, cut out of the pureſt ſalt, and decorated with four columns ten feet in height, one and a half in diameter, and perfectly tranſparent: it is ornamented all around with ſculpture repreſenting the attributes of the vine and agriculture: on the right is Jeſus on the croſs, of the natural ſize, and executed with great elegance; on the left is a ſaint in the attitude of offering up his devotions, the work of the ſame chiſel: three ſteps conduct to the altar, which is richly ornamented with elegant veſſels of ſalt; and the whole receives a very remarkable degree of ſplendour from about thirty ſmall flambeaux lighted around it.

In this place the ſalt is remarkably pure, and is diſtinguiſhed by the name of *ſchibika*; the ſecond kind, which is found at the diſtance of a few fathoms, is mixed with argil, and is called *grün*; the third, called *ſpiza*, is mixed with calcareous earth, argil, and water: the argil is almoſt always of a ſchiſtous form and of a dark gray colour; in ſome morſels it ſerves as a baſe to the calcareous earth, diſpoſed with great elegance in cottony balls, exceedingly white and of different ſizes.

The ſtrata of ſalt are always parallel to the ſurface of the mountain; but no regularity has hitherto been obſerved in the reſpective ſituations of the different ſtrata: they are often ſeparated from each other by ſtrata of argil, and in ſome places interſected by veins of calcareous ſpar: where the air is dampeſt the ſoil falls into a ſtate of efflorescence, and is remarkably white; every where elſe the colour varies from blackiſh blue to a dirty white. Where the water is collected and remains the ſalt diſſolves, and then ſhoots into very regular cubic cryſtals: cryſtals of the like kind are found ſometimes buried in the mountain itſelf; the cryſtallization found there is quite formed in the manner of four ſteps of equal dimenſions, which, placed in a ſquare, and converging towards a centre, form a pyramid of great elegance and regularity.

We proceeded from the altar through a large alley fifteen feet in height and twelve in breadth, entirely cut out in the ſalt, which conducted us to an immenſe magazine filled with caſks. This cavity, of an enormous ſize, conſtructed at the depth of 120 feet below the ſurface of the earth, was ſupported only by four pillars of ſalt, and theſe even were conſidered as ſuperfluous. The ſides of this hall conſiſt of ſalt

more

more or leſs pure, which reflected the rays of light proceeding from our lamps in a thouſand different points. We then directed our courſe to a large ſtair of a hundred ſteps, each nearly fifteen feet in length and one in breadth, covered with planks to preſerve the angles of them: by this ſtair we deſcend twenty-five fathoms without experiencing any very ſenſible change in the temperature; the dampneſs of the air even is ſo weak, that planks which have been in uſe for upwards of a hundred years, and at the depth of 270 feet below the ſurface of the earth, appear ſtill as freſh as if new. The workmen aſſured me that they experienced almoſt the ſame degree of heat during the whole year: the air here is ſo ſurcharged with ſalt that the ſaline particles are depoſited on the hair, eyebrows, and eyelaſhes of the workmen.

We ſoon arrived at a hall of as great extent as the former, in which the miners were employed in digging out the ſalt with great activity. By the chiſel and gunpowder they ſometimes cut out blocks three feet in breadth, and ſufficiently thick to form three maſſes, each weighing 560 pounds. When the edges are rounded off, they give them the form of an elliptical caſk.

The workmen employed in theſe mines are in number 800; they work in the interior of the mine from five o'clock in the morning to one in ſummer, and from ſeven to three in winter. They are naked to the middle, (which announces a very mild temperature,) and are not ſubject to any particular malady: their paleneſs ariſes from the want of light and bad nouriſhment. They have nothing to dread but the terrible exploſions which often burſt forth from places formerly worked and now cloſed up. At the moment when they enter with their lamp, the air ſeems as if traverſed by flaſhes of lightning in every direction: the combuſtion is ſudden, extends to the neighbouring galleries, extinguiſhes the lamps, and ſeverely ſcorches the workmen if they do not throw themſelves flat on their faces.

We now deſcended a ſecond magnificent ſtaircaſe to the depth of 30 fathoms more, and of 450 feet below the ſurface of the mountain, where we found horſes yoked to a wheel like the former, and which ſerves to move the rope that brings up the ſalt dug out in the lower galleries. Theſe animals paſs the greater part of their lives in theſe ſubterranean regions, and yet enjoy good health. At ſome diſtance is a large ſtable with ſix pair of horſes which relieve each other. Being here ſtruck with a ſtrong ſmell of ſulphur, I found that it aroſe from the diſengagement of ſulphurized and phoſphorated hydrogen gas, produced by the fermentation of the

horſes' dung, and, in my opinion, muſt greatly contribute towards thoſe aërial exploſions of which I have ſpoken.

We next proceeded to a neighbouring gallery, where, after two hours' reſpectful admiration, we were filled with a ſentiment of aſtoniſhment and ſurpriſe which it is impoſſible for me to deſcribe. Through the enormous maſs of ſalt, which preſents to the eye no interruption in its ſaline texture, and at the depth of 450 feet, flows a ſtream of pure freſh and tranſparent water, which is received in large wooden veſſels, where the workmen and horſes of theſe ſubterranean regions quench their thirſt. As it was impoſſible that this ſpring could filter through the ſalt, Nature, which buries her maſterpieces in the bowels of the deepeſt mountains, has placed in this monſtrous maſs of ſalt a ſtratum of clay ſufficiently thick to allow this ſtream of water, deſtined to refreſh the workmen, to paſs through it in ſuch a manner as to be protected from the action of the ſalt, of which a very ſmall quantity would injure its ſalubrity. To viſit a place where Nature ſeems to have ſcattered her gifts with profuſion, and to have concentrated her moſt valuable ſecrets, muſt be highly intereſting.

We now ſet out to quit the mines, and in our way found ſeveral other altars recently cut out from the ſalt, and in a very neat manner, which diſplayed conſiderable taſte. Having ſoon reached the bottom of one of the pits, we placed ourſelves, as before, on ſeats made of rope, and arrived in ſafety at the village of Wielitſka. By an eſtimation, made nearly fifty years ago, of the ſize of theſe mines, it appears that they extend from eaſt to weſt 6000 German feet, from north to ſouth 2000, and to the depth of more than 800.

The working of theſe mines, which gives bread to more than 400 families, enriches the village, and ſupplies the neighbouring countries with ſalt, produces more than 168,000 quintals per annum, and brings to the emperor a net profit of five millions of florins.

Such are the moſt intereſting circumſtances which I obſerved at the famous mines of Wielitſka, of which ſo many fabulous deſcriptions have been given, and againſt which people ought to be on their guard: it is even aſtoniſhing that where the mind can ſcarcely ſeize the grandeur of what Nature preſents, the imagination ſhould ſtill be ſo lively as to ſee there "people who never behold the light of the ſun, who inhabit ſubterranean villages, who govern themſelves according to their own laws," &c.

During my ſtay at Cracow, I formed a deſign of viſiting alſo the ſalt mines or mountains of ſalt at Bochnia, five leagues ſouth-

south-east from Cracow, to which I repaired for that purpose; but I was not allowed to descend into them, for want of the necessary written orders. They are constructed like those of Wielitska; but the pits are deeper, and they contain more of that kind of salt called *schibika*. The salt, however, is neither so pure nor so various in its nature, nor are there to be seen in the latter any of those masterpieces of art above described. Large fragments of black wood and alabaster are often found mixed with the salt.

XLVII. *Account of Lord* DUNDONALD'S *Discovery of a Process for extracting from Lichens a Gum applicable to most Purposes in which Gum Senegal has been hitherto employed.*

THIS important discovery was announced by a circular letter from his lordship, which was followed by a meeting of calico printers at Glasgow, and the publication of different papers, a perusal of which will put our readers in possession of all that has yet transpired respecting this business. The following are copies of the letter and papers alluded to:

To Calico Printers and other Consumers of Gum Senegal in Scotland.

GENTLEMEN, April 23, 1801.

IT is now upwards of nineteen years since I discovered that a gummy extract, or gum, (equally well adapted as gum Senegal for most purposes in which that article is employed,) was to be procured, by an easy process, from the plant called in botany *lichen*, or the moss which grows on trees and hedges; to be had in considerable quantities in many parts of this country, and still in much greater abundance in Sweden, Norway, and in the northern parts of America.

At the time I made this discovery other objects, apparently more important, occupied my attention; but having, some months ago, been informed that foreign gums had risen to such a price as to bear hard on several branches of manufacture, I again turned my attention to the preparation of gum from the lichen, and can now, with confidence, inform you that it answers equally well as gum Senegal for your branch of manufacture. I intended at one time to have taken out patents, but have now come to the determination of laying my invention open, for the benefit of the calico printers and other consumers of gum.

With this view, I invite you to meet me at the Black Bull inn, Glasgow, at twelve o'clock, on Tuesday the 28th current, when samples of the raw material and prepared gum extract shall be shown you; directions given how to prepare it, as well as information from whence a sufficient supply of the raw material is to be had.

My life has, in a great measure, been spent in pursuits which appeared to me calculated to advance the manufactures, commerce, and agriculture of my country: to the attainment of these objects, it is well known, I have sacrificed what fortune I possessed. It would therefore be affectation in me to say, that I am independent of such pecuniary recompense as the communication offered to be made may be thought deserving of. This I leave to yourselves, and to the other calico printers and consumers of gum in Great Britain and Ireland. Exclusive of any considerations personal to myself, it gives me satisfaction that I have been able to render you independent of foreign nations for the supply of an article so indispensably necessary for your manufacture, and that at a rate not exceeding 1-12th part of the present price of gum Senegal.

I am, gentlemen,
Your obedient servant,
DUNDONALD.

Lord Dundonald's Gum Substitute.

Glasgow, May 7, 1801.

AT a meeting of calico printers, called by public advertisement, to consider of a plan of recompense to the earl of Dundonald, for laying open, in the handsome manner he has done, his discovery of a substitute for gum Senegal and other gums, James M'Dowall, Esq. in the chair, the meeting came unanimously to the following resolutions:

1st, That the discovery of the use of lichen, &c. as a substitute for gum, is likely to be of great advantage to calico printers, and of national importance.

2dly, That Lord Dundonald should be liberally rewarded for that discovery; and that an annual sum per table, and presses that use gum, is considered by the meeting as the best and most certain method of recompense.

3dly, That the meeting, either by themselves or in conjunction with others, are willing to support Lord Dundonald in an application to Parliament for an act to secure to his lordship the benefit of this discovery on such conditions as may be previously agreed to.

JAMES M'DOWALL, Præses.

Statement

Statement of the Benefits and Advantages to enſue to Individuals and to the United Kingdom of Great Britain and Ireland, from Lord Dundonald's Diſcovery of extracting Gum from the Lichen or Tree Moſs, as a Subſtitute for Gum Senegal and other foreign Gums.

GUM Senegal, or other foreign gums, have hitherto been indiſpenſably requiſite for printing fine goods, and thoſe of light ſhades of colour.

No proper ſubſtitute had been found to anſwer for this part of calico printing until Lord Dundonald diſcovered the preparing gum from the lichen.

Gum Senegal, and foreign gums, are at times ſcarce, and difficult to be procured.

The ſettlement of Senegambia belongs to the French: they have a monopoly of gum Senegal. The price ſince the war has riſen from 150*l.* to 400*l.* per ton.

Gum from the lichen may, all charges included, be prepared at 1-14th part of the preſent price of gum Senegal, and at 1-6th of the peace-time price.

The united kingdoms may now be ſaid to be independent of foreign ſtates for the gum requiſite for their manufactures, ſuch as calico printing, preparation of ink, ſtaining and manufacture of paper, dreſſing and ſtiffening ſilks, &c. &c. And, in conſequence of Lord Dundonald's diſcovery, large ſums of money, formerly ſent abroad for the purchaſe of gum, will, in future, be ſaved.

Starch and wheaten flour have hitherto been uſed as cheap ſubſtitutes for gum in printing coarſe goods, or to fix on other printed goods, the mordants, and ſome of the dyeing materials, for deep ſhades of colour. But there is now reaſon to expect, as gum from the lichen will coſt leſs than thoſe articles, particularly ſtarch, it will be uſed in their ſtead, and ſo prove the means of ſaving or œconomizing a conſiderable portion of wheat and wheaten flour at preſent conſumed in calico printing.

The collecting the lichen from the foreſt and fruit trees and hedges, will give employment to a number of poor people, principally women and children.

A cheap ſupply of gum from the lichen may, perhaps, in ſeveral manufactures, ſuperſede the uſe of the higher priced article of glue or ſize, which often has a very diſagreeable ſmell.

Gum from the lichen may, perhaps, be uſed as a dreſſing in weaving, particularly fine goods, either by itſelf or when

made into a kind of soap, according to directions given in a separate publication.

Lastly, It is probable that all the benefits to ensue from the discovery of procuring gum from the lichen may not yet have occurred, it being well known that there is no art or discovery that is not the parent or sister of some other.

Statement of the Expenses of collecting the Lichen or Tree Moss, preparing the Gummy Extract, and Amount of the Saving to accrue to Calico Printers by using it as a Substitute for Gum Senegal, reckoning Gum Senegal at different Prices, from 7l. to 20l. per cwt.

	£.	s.	d.
To gathering 1 cwt. of lichen, at 2*d.* per lb.	0	18	8
To carriage, on an average distance of 30 miles, at 2*s.* per cwt.	0	2	0
To 7 lb. pearl ashes, at 56*s.* per cwt.	0	3	6
To boiling ditto, say half the price of gathering	0	9	4
	1	13	6
But say the lichen cost in gathering 3*d.* then there falls to be added	0	9	4
Charges on the cwt. of lichen	£. 2	2	10

But with a view to a comparative statement with gum Senegal, this must be reduced 1-3d, as a cwt. of dry lichen has been found to do as much work, in calico printing, as one cwt. and a half of gum Senegal.

In all, the value of the gum extract, on which a comparison is to be made, after deducting one-third, will only cost, say 29*s.*

Thus, when gum Senegal is at 20*l.* per cwt. a substitute is to be had at 1-14th of that price.

When at £. 15, at 1-10th
£. 10, at 1-7th
£. 7, at 1-5th

And, on an average of the peace and war time prices, at 1-9th of the price of gum Senegal.

An individual in the calico printing line informed Lord Dundonald, last November, that at the then prices, viz. 15*l.* per cwt. the supply of gum Senegal for his works cost him upwards of 5000*l.* per annum.

Say	£. 5000
An equal quantity of gum from the lichen, at the price stated, would cost, say	500
In all, a saving annually of	£. 4500

And

And ſuppoſing 100 tables or preſſes uſing gum, there would be an annual ſaving of 45*l.* per table; or an annual ſaving of 22*l.* 10*s.* when gum fell to the peace-time price of 7*l.* 10*s.* per cwt.

Directions by Lord Dundonald for extracting Gum from the Lichen or Tree Moſs, &c.

IT does not appear, from ſuch trials as Lord Dundonald has hitherto made, that there is any very great difference in the produce of gum from the lichen collected from different trees or ſhrubs: all of them anſwer equally well for yielding a gum fit for calico printing. The lichen is moſt abundant on the trees which grow in a poor, ſtiff clay ſoil, particularly if ſituated at ſome conſiderable height above ſea level. It ſhould be pulled in dry weather, otherwiſe it is apt to break in the pulling; beſides, in this caſe, requiring to be dried before it can with ſafety be laid up in the ſtorehouſe, where, if put in dry, it may be kept for years. Should a ſufficient quantity of it not be found in this country, it may be had in almoſt unlimited abundance in Sweden, Norway, and in the northern parts of America, where it grows to the length of from a foot to eighteen inches, and preſſing the branches of the tree by its weight. There is, however, every reaſon to believe that a ſufficient quantity is to be had in this country. According to information from Dr. Brown, lecturer on botany, it takes three or four years in coming to maturity or its full ſize, ſo that a crop from the ſame tree may be had every fourth year.

The lichen does not conſiſt entirely of a gummy matter. There is the outer ſkin or cuticle, below that a green reſinous matter: the remainder of the plant conſiſts of partly gum, partly a matter ſomewhat analogous to animal ſubſtances, and a ſmall proportion of fibrous matter, which cannot be diſſolved by boiling, or the action of alkaline ſalts.

The firſt proceſs in preparing gum from the lichen is to free it of the outer ſkin of the plant and the reſinous matter. This is done by ſcalding the lichen two or three times with boiling water, allowing it to remain ſo long in the water as, by abſorbing it, to ſwell: in doing this the ſkin cracks and comes off along with the greateſt part of the reſinous matter. Or it may be freed from them by gently boiling the lichen for about fifteen or twenty minutes, then waſhing it in cold water, laying it afterwards upon a ſtone or brick floor, where it ſhould lie for ten or twelve hours, or perhaps more. The reaſon for this is, that the expoſure for that time to air greatly facilitates the ſubſequent extraction of the gum.

The ſcalded lichen is then to be put into a copper boiler with a due proportion of water, ſay three Scotch pints, or two wine gallons, to every pound of lichen, and boiled during four or five hours, adding about half an ounce or three quarters of an ounce of ſoda or pearl-aſhes for every pound of lichen; or, inſtead of theſe ſalts, about half an Engliſh pint of volatile alkali. The boiling ſhould be continued until the liquor acquires a conſiderable degree of gummy conſiſtence. It is then to be taken out of the boiler, allowed to drain or drip through a wire or hair cloth, or ſearſe. The reſiduum to be put into a hair cloth bag or bags, and to be ſqueezed in a preſs ſimilar to that which is uſed by the melters or rinders of tallow.

The firſt boiling does not extract the whole of the gum. The lichen ſhould be boiled a ſecond and even a third time, repeating the proceſs as above deſcribed, diminiſhing at each proceſs the quantity of water and the quantity of alkali, which a little experience will ſoon point out. When three boilings are employed, the gummy extract of the laſt boiling ſhould be kept for the firſt boiling of a freſh batch of lichen. The extract proceeding from the firſt and ſecond boilings ſhould be mixed together, and evaporated to the conſiſtence neceſſary for block or preſs printing. The evaporating veſſels ſhould be of tin or thin lead, placed over a range of ſtoves, and moderately heated by fire or the ſteam of water. It has been neglected to ſtate, that before evaporating the gummy extract to the conſiſtence neceſſary, it ſhould be kept ten or twelve hours, ſo as to allow the ſediment or dregs to ſubſide. The clear liquor may either be drawn off by a ſyphon, or the dregs may be drawn off by a cock at the bottom of the wooden veſſel; the bottom of which ſhould be made ſloping, higher at the back than the fore part, in order that the dregs may run more completely off. The proportion of gummy matter remaining in the dregs may be got off by mixing them with a due proportion of boiling water, allowing the liquor to clear, and proceeding as above directed, employing this weak ſolution for boiling the next batch of lichen.

The reſiduum of the lichen, after the third boiling, conſiſts of a matter ſomewhat analogous to that of animal matter, together with a proportion of the fibrous matter of the plant. From the animal matter a kind of ſoap may be made. The proceſs is as follows:

Let a ſmall proportion of pounded reſin be diſſolved by boiling in a ſolution of alkaline ſalts. When the reſin is diſſolved, put in a certain quantity of the reſiduum of the lichen, and continue the boiling until this laſt article is pretty

well

well diſſolved. Then add about a pound or a pound and a half of white ſoap, ſhaved down or cut into thin ſlices, to every ten pounds weight of the reſiduum of the lichen. Continue the boiling until the white ſoap is fully diſſolved. Then paſs the ſoapy ſolution through a hair ſieve or hair bag. Let the ſoap pan then be cleaned out, and the ſoapy ſolution returned to the pan, to be boiled to the conſiſtence neceſſary. A kind of ſoap very ſimilar to this may be made from ſea weed, as well as from ſeveral other articles. Of this and of other matters highly important to calico printers, a more full and detailed account will be given in a future publication. When gum from the lichen is to be employed for making ink, manufacturing and ſtaining paper, and for ſtiffening ſilks, crapes, and gauzes, it ſhould be extracted from the lichen without employing any alkaline ſalts, continuing the boiling or digeſtion longer, and with a moderate degree of heat, in which caſe the gummy extract will be nearly colourleſs. When volatile alkali is uſed, the boiler ſhould be of iron, as volatile alkali acts on copper.

[We have not yet learnt the iſſue of the negotiation between Lord Dundonald and the calico printers in Scotland; but we underſtand his lordſhip has taken out a patent for his invention for England.]

XLVIII. *An Eſſay on Bleaching; with the Deſcription of a new Method of Bleaching by Steam, according to the Proceſs of* C. CHAPTAL; *and on its Application to the Arts. By* R. O'REILLY, *of the Academy of Bologna, Member of the Lycæum of the Arts, &c.*

[Concluded from p. 264.]

Reſtoration of Books, and whitening Prints.

THE oxygenated muriatic acid has the property of whitening paper without altering its texture. Chaptal firſt made known the proceſs for this purpoſe, which is valuable for reſtoring old books, and prints ſtained with ſmoke. His proceſs has even been executed, with aſtoniſhing ſucceſs, by Vialard and Heudier; when the leaves are not too much decompoſed by time, the oxygenated liquor or the acid gas is employed. Immerſion in the liquor is to be preferred, as being more expeditious.

[The author here gives C. Chaptal's proceſs, for which ſee Philoſophical Magazine, Vol. II. p. 28. Inſtead, however,

of directing the cylindrical glaſs veſſel, in which torn and paſted prints are put when cleaned, to be inverted on water charged with materials fit for extricating the oxygenated muriatic acid gas, his recipe directs the materials to be put in the bottom of the jar itſelf, which is certainly better. Great accuracy, however, is neceſſary in the doſes and in the conducting of the proceſs, otherwiſe the texture of the paper may be deſtroyed.]

Bleaching by the oxygenated Muriatic Acid and Potaſh.

The ſuffocating emanation of the gas has rendered it neceſſary to employ potaſh in the liquor; but this mixture, though it enabled the workmen to manage the ſtuffs without inconvenience, occaſioned an outlay of money for the alkali, and weakened the deterſive quality of the oxygenated muriatic acid. It is a fact well known, that a ſolution of oxygenated muriate of potaſh does not bleach goods, yet it differs from the oxygenated muriatic acid ley only by having the alkali in it: it is, then, inconteſtable that the acid liquor loſes its property of deſtroying the colouring matter of vegetables in proportion as it is neutralized by potaſh.

Notwithſtanding the truth of this obſervation, it is proper to ſay a few words reſpecting the method of compoſing this ley: the proportion of the alkali in general is,

8 parts (in weight) of ſea ſalt,
60 parts of concentrated ſulphuric acid,
30 parts of manganeſe,
20 parts of potaſh.

The ſubſequent preparations and manipulations are exactly the ſame as thoſe I above deſcribed; it will however follow, from the obſervation I have made, that the diminution of the detergent force by the alkaline mixture will render a great many more manipulations neceſſary; and if we add a comparative calculation of the two operations, it will be found, without including the expenſe of diſtilling the oxygenated muriatic acid, which is the ſame in either proceſs, there will be a ſaving of more than forty-five per cent. beſides the extra manipulations, in not employing alkalies. We here ſubjoin a comparative calculation.

With Alkali.	francs.
8 lb. marine ſalt, at 15 cents. per lb.	12
60 ditto ſulphuric acid, at 65 cents.	39
30 ditto manganeſe, at 20 cents. -	6
20 ditto potaſh, at 75 cents. -	15
	72

As

As the ley loſes its force by the addition of potaſh, this loſs may be eſtimated at 15 per cent., or 10 f. 80 cents., which muſt be added to the preceding 72 francs, making together 82 f. 80 cents.

Without Alkali.

	francs.
80 lbs. of ſea ſalt, at 15 cents. per lb.	12
60 ditto ſulphuric acid, at 65 cents.	39
30 ditto manganeſe, at 20 cents. -	6
	57

The difference between theſe two proceſſes is conſiderable.

Of Bleaching with oxygenated Muriates.

This method was firſt thought of in Ireland. The ſubſtance employed is the oxygenated muriatic acid combined, as we have ſaid, with earthy or ſaline baſes. Calcareous earths, ſuch as lime and chalk, are thoſe uſed in general; magneſia is too dear, and the rarity of barytes and ſtrontian will exclude them for ſome time from our manufactories. A diſtilling apparatus of lead, ſuch as we have already alluded to, (p. 259,) is employed. A tube *l*, (ſee Plate IV. the lowermoſt figure) three inches in diameter, riſes from the top of the alembic *g g*, and proceeds to the bottom of a leaden reſervoir *m*, capable of containing about 15 gallons, two-thirds of which are filled with water. Another tube *n*, of the ſame dimenſions, alſo of lead, the orifice of which is above the level of the water, riſes from the reſervoir *m*, and enters the tub *o, o*, in which the liquid oxy-muriate of lime is prepared. This tub muſt be large enough to contain twelve barrels, or about 1500 (Engliſh) gallons of water: 80 pounds of lime, ſlaked in the air and well pulverized, is introduced into it: the ſides of this tub are furniſhed with ſhelves or a grating, *q q q*, which projects in the inſide, while the arms of the agitator *t*, to which a rotatory motion is communicated, move between the ſhelves, and conſtantly ſtir the liquor: this diſpoſition is indiſpenſable to prevent the lime from being precipitated before its ſaturation, and to preſent, by renewing them, the greateſt number of ſurfaces poſſible to the action of the acid gas. The uſe of the intermediate reſervoir, *m*, is to arreſt the portion of the muriatic acid gas which eſcapes during the commencement of the operation without being oxygenated, and alſo any ſulphuric acid which may chance to paſs, and which would hurt the proceſs if it were ſuffered to be introduced into the tub *o, o*. The property which the

muriatic

muriatic acid has of eaſily combining with water, facilitates its condenſation by the intermediate reſervoir.

By drawing out a little of the ley from time to time one may know when the liquor in the tub is ſaturated. When it ſuffers the lime introduced to be precipitated, the operation is terminated. This oxy-muriate of lime is drawn off from its depoſit, and it is then ſufficiently concentrated to be employed for bleaching when diluted with three times its volume of water.

This liquor is found to be preferable to the oxygenated muriatic acid and potaſh. At the great bleach-fields in Ireland, four leys of potaſh are applied alternately with four weeks expoſure on the graſs, two immerſions in the oxygenated muriate of lime, a ley of potaſh between the two, and the expoſure of a week on the graſs between each ley and the immerſions. During ſummer, two leys and fifteen days expoſure are ſufficient to prepare cloth for the action of the oxygenated muriate; then three alternate leys, with immerſions in the liquor, will be ſufficient for complete bleaching: nothing then will be neceſſary but to wind the cloth through the ſulphuric acid.

Bleaching by calcareous Sulphuret.

In all the proceſſes for bleaching which I have hitherto deſcribed it is ſeen that potaſh acts a diſtinguiſhed part, either as an auxiliary or a principal agent. To find a deterſive ſubſtance which might be a ſubſtitute for it, was an object of the utmoſt importance. Kirwan ſuſpected that it would be found in the ſulphuret of lime, and his opinion was confirmed by Higgins.

Repeated trials, and the moſt evident ſucceſs, have proved the advantage of employing this method, and the poſſibility of bleaching completely by condenſing the muriatic acid with the ſulphuret inſtead of potaſh. The proceſs with the ſulphuret of lime is attended with ſome advantages peculiar to itſelf. In the firſt place, quicklime and crude ſulphur are matters which can be procured at a cheap rate, eſpecially when the latter enters into the mixture in ſmall quantity: ſecondly, their combination is effected in the eaſieſt and moſt expeditious manner, and may be comprehended and executed by any common workman: the application being then made by immerſing the cloths cold, there is a complete ſaving of fuel, and no riſk is incurred either from the ignorance or negligence of the workman, as the ley does no injury to the ſtuffs.

The ſulphuret of lime is prepared in the following manner: Take 4 pounds of finely pulverized ſulphur, 20 pounds of

ſlaked

ſlaked lime ſifted, and 16 gallons of water. When the whole is well mixed, it muſt be kept in a ſtate of ebullition for half an hour, ſtrongly ſtirring it ſeveral times. When the ebullition ſubſides, the ſolution of the ſulphuret becomes clear: the liquor may be drawn off from the inſoluble depoſit by means of a ſyphon *. The liquor will have the colour almoſt of ſmall beer, but is not quite ſo tranſparent.

Sixteen gallons of water muſt ſtill be poured over the depoſit, to take away entirely the remaining ſulphuret. When the liquor becomes clear, (it muſt firſt be well ſhaken,) it is drawn off and mixed with the former: to this mixture of the two liquors 33 gallons of water are to be added, in order to reduce it to the degree of ſtrength neceſſary for the immerſion of cloth.

Making allowance for the water evaporated, and for that retained by the precipitate, there ought to remain 60 gallons of liquor produced by the four pounds of ſulphur.

The cloth freed from the weaver's dreſſing muſt then be immerſed for twelve or thirteen hours in the ſolution of ſulphuret, and be then rinſed in running water. When dry, it is immerſed for twelve or fourteen hours in a ſolution of oxygenated muriate of lime prepared as I have deſcribed, and it muſt then be waſhed and dried as before. The operation muſt be repeated ſix different times; that is to ſay, there muſt be ſix immerſions in each liquor, which will be ſufficient for bleaching it completely. Cloths boiled ſix times in a ley of potaſh, and immerſed as many times in oxygenated muriatic acid, were not whiter than thoſe bleached by the new method.

The cloth, indeed, after the three firſt times it was boiled in the ley of potaſh, ſeemed a little whiter than thoſe immerſed as many times in the ſulphuret: but towards the end of the operation, when the cloth was completely bleached, the advantage was in favour of the ſulphuret, or, at leaſt, the difference was not ſenſible. The cloths whitened by potaſh ſeemed more meagre than thoſe which had been treated by the ſulphuret, and ſupported the proof of being boiled with ſoap better than others; though the latter had acquired in ſome inſtances a ſlight yelloviſh ſhade, which, however, diſappeared after ſix or ſeven days expoſure on the graſs.

An experiment has been tried on the effect of ſulphuret cold and warm, but the difference was ſo little that it did

* Though lime is one of the conſtituent parts of the ſulphuret, as it is intimately united to ſulphur, it has no longer the properties of lime, for the ſame reaſon that the *ſulphuric acid* in the *ſulphate of potaſh* has no longer the properties of that acid.

not

not deſerve to be taken into conſideration. Cloths immerſed in the ſulphuret, and then boiled in a ley of potaſh, and afterwards introduced into the oxygenated liquor, are whiter than after they have been ſubjected to two immerſions in the ſulphuret, and been made to paſs through the ley: thus the two ſubſtances ſeemed deſirous of co-operating. Two ſucceſſive immerſions, however, in the ſulphuret, before being immerſed in the oxygenated liquor, produced a better effect than one immerſion; which is not the caſe with potaſh.

It is of importance to obſerve, that ſtuffs are always and invariably thicker and more ſwelled up when they come from the ſulphuret of lime than after they have been ſubjected to the ley of potaſh; and they continue to retain theſe qualities even after they have been waſhed, and dried on the graſs. The ſulphuret opens the fibres of the cloth better and more ſpeedily than potaſh, by ſoftening them, and rather by making them ſwell up, than by diſſolving the extracto-mucous or colouring matter. This may ſerve to explain why potaſh produces a better effect on cloth when it has been before immerſed in a ſolution of ſulphuret of lime.

The proprietors of bleach-fields, who perſiſt in not making uſe of the oxygenated muriatic acid, but who bleach in the open air, may perhaps derive ſome advantages from this proceſs, if they uſe ſulphuret of lime and potaſh either conjointly or ſeparately. The advantage and ſaving of expenſe which reſult from ſulphuret of lime are evident: for ten years the price of ſoda and potaſh has been exceſſively dear, and has always increaſed. In all Europe, at preſent, the latter article coſts about 70 francs (about 2*l.* 18*s.*) per hundred weight; and ſoda is nearly a third leſs. Sulphur may be eſtimated at 25 or 30 francs; on the other hand, lime, as it is every where found, coſts very little; the price of this deterſive liquor, therefore, will become ſo low that we have no coin ſmall enough to repreſent the value of a quart of it. The truth of this fact will appear by a compariſon with the price of common ley.

At large bleach-fields the ley is made by diſſolving four pounds of potaſh, or ſix pounds of ſoda, in 60 gallons of water: ſome employ a little more: but four pounds of potaſh at 70 cents. make two francs 80 cents., and a like quantity of ſulphur at 25 cents. makes one franc: but this is not all, as there is a ſaving in fuel as well as of materials; no more is required than the quantity neceſſary for boiling eight gallons of water, while the common ley requires that 64 ſhould be brought to the ſtate of ebullition. The time requiſite for heating this maſs of water preſents alſo a ſaving which is

far

far from being a matter of indifference in a large eſtabliſhment. To this we may add, that in the application of theſe deterſive liquors the cloth muſt be boiled at leaſt ſeven hours in the alkaline ley, while the ſolution of ſulphuret of lime requires only half an hour; and even if we ſuppoſe that potaſh ſhall continue to be uſed along with the ſulphuret of lime, as is the caſe at preſent in Ireland, the ſaving will be ſtill very conſiderable.

Bleaching with Steam.

The different proceſſes which we have hitherto deſcribed form almoſt an hiſtorical abridgement of the art of bleaching. We have followed the progreſs of the human mind; and, indeed, a plain account of the various proceſſes and different kinds of apparatus ſufficiently ſhows what ſervice has been rendered to this important art by modern chemiſtry.

But it ſtill remains to make known a new method, for which we are indebted to Chaptal. This reſpectable chemiſt publiſhed, about two years ago, a notice reſpecting the method of bleaching by ſteam; a proceſs brought to us from the Levant ſome time after the introduction of that for dyeing Adrianople red, and which is now uſed in the ſouth of France under the name of *blanchiment à la fumée*. Till the period when Chaptal was ſo diſintereſted as to diſcloſe it to the public, it was a ſecret the knowledge of which was confined to a certain number of manufacturers. It was employed only for bleaching cotton and cotton thread after the manner of the orientals; but C. Chaptal foreſaw, with his uſual acuteneſs, the poſſibility of applying this method to bleaching linen and hemp thread; and he invited manufacturers to adopt this proceſs, in order to improve it and extend its uſe.

Chaptal's invitation excited ſeveral manufacturers both in France and in foreign countries. Almoſt at the ſame time, the effects of the new method of bleaching were tried in the neighbourhood of Paris and in Ireland: the apparatus ſeen at the cotton manufactory of C. Bawens, at Bons-Hommes, near Paſſy, gives the moſt aſtoniſhing reſults. It can bleach from two to three thouſand yards of cotton cloth per day, at a price ſo moderate, and with ſuch facility, that no other proceſs can be compared to it. The firſt experiment which he tried was made on fifteen hundred yards of cloth deſtined for being printed: it exhibited no blemiſh or ſhade, but was all equally white.

His apparatus has a perfect reſemblance to that deſcribed by Chaptal, and which may be employed exceedingly well

alſo for bleaching raw cotton or cotton thread. Though the diſpoſitions which we have recently made preſent great advantages, yet as this new art is, as we may ſay, only in its infancy, we ſhall deſcribe, in the words of Chaptal, an apparatus ſimilar to that which C. Bawens has cauſed to be conſtructed.

"At about the diſtance of ſixteen inches from the grate of a common furnace, heated by pit-coal, is placed a copper boiler of a round form, four feet in diameter and eighteen inches in depth. The edges of this boiler, which are about ſeven inches in breadth, and turned backwards, reſt on the lateral edges of the brick-work of the furnace. The remainder of the furnace is of cut ſtone, and forms an oval boiler, the height of which is ſix feet, and the breadth, meaſured at the centre, five feet. The upper part of the boiler forms a round aperture, the diameter of which is eighteen inches. This aperture may be ſhut by a ſort of moveable ſtone, or a copper lid fitted to it. On the edge of the copper boiler, which forms the bottom of this kind of digeſter, is placed a grating formed of wooden bars, ſo cloſe to each other that the cotton laid upon it cannot fall through between them, and ſtrong enough to ſuſtain the weight of about 1600 pounds."

In the apparatus of C. Bawens, the mode of heating employed in Count Rumford's furnaces has been adopted in order to ſave fuel. The heat of the chimney is applied to heat a veſſel containing diluted ſulphuric acid. (See the three uppermoſt figures of Plate IV.)

The apparatus propoſed in other countries afforded the advantage of being able to wind up the cloth in the inſide: it was, as we may ſay, the boiler of a ſteam-engine, with its tubes, ſafety-valves, and leather collars; but it was neceſſary to introduce the ſtuffs at the top, which is very inconvenient.

With theſe data, and after having maturely reflected on the means of improving this apparatus, I invented ſeveral kinds proper for being applied to different kinds of goods.

The firſt, which I propoſed to be executed at Jouy, repreſented a chamber, arched with cut ſtone, ſix feet eight inches in length, three feet ten inches broad, and three feet and a half in height above the level of the wooden grate. (See Plate V. fig. 1.) At one of its extremities was a door, K, two feet in height and three feet long, covered with a plate of caſt iron, in which was a hole for introducing a conic valve, kept in its place by a very powerful ſcrew and ſpring. The object of this valve was to guard againſt an exploſion, which

which might be occaſioned by the extraordinary effort of the ſteam; an event much to be apprehended. The door, which was moveable, was faſtened by ten bars and as many ſcrews, which preſſed it againſt the rabbet (already faced with tow or moiſtened leather) until it was ſo cloſe that none of the ſteam could eſcape. For the greater convenience it ought to be furniſhed with two iron handles, in order that it may be taken off with more eaſe.

The boiler E, E, E, which forms the bottom of this chamber, and in which the alkalino-cauſtic ley is boiled, is 18 inches in depth: its other dimenſions are four inches leſs than thoſe of the chamber. This diminution is deſtined for receiving the edges of the boiler, which thus ſerve to ſupport it, as well as a wooden grate, over which the workmen paſs during the manipulation. In the middle of this chamber are placed two reels, A and B, on which are rolled up from 18 to 20 pieces of cloth. The axes of theſe reels paſs through leather collars, which prevent the eſcape of the ſteam, and the cloth is rolled up and unrolled by handles fixed on the outſide. A regulator, H, which communicates with the inſide of the boiler, indicates the height of the ley and the ſtate of its exhauſtion. The boiler is heated in the uſual manner, or by Count Rumford's plan.

I cauſed to be conſtructed at Troyes another apparatus deſtined for bleaching hoſiery. As theſe articles cannot be unrolled, and as heaping them together might impede the action of the vapour, I employed frames covered with cloth, and placed at the diſtance of four inches above each other. On theſe the hoſiery was depoſited in ſuch a manner, that the vapour, in riſing from the boiler, might penetrate it in every part, deſtroy the colouring matter, and bleach it completely.

Some new obſervations induced me to propoſe for the winding of cloth a roller, which might be immerſed at pleaſure in the boiler in order to moiſten the cloth from time to time. All theſe kinds of apparatus will be explained hereafter.

Having thus ſpoken of the inſtruments employed in this new art, I ſhall examine the principles on which it is founded, and deſcribe the beſt method of bleaching by this proceſs.

The bleaching of vegetable ſubſtances depends on the deſtruction of their colouring principle by the combined action of the air, moiſture, and light, or rather, by the united influence of theſe principles to alter their natural colour.

Alkalies have on the colouring matter of vegetables an action which produces the effect of a real combuſtion. Were

we intimately acquainted with the nature of potaſh and ſoda, we might be able to explain the *cauſe* of this burning; but it is ſufficient for us at preſent to know the *effect*. The expoſure of vegetable matters on the graſs ſubjects them to the action of the ſolar rays; and moiſtening them during their expoſure facilitates, with the vaporization of the water, the emanation of the carbonic acid formed by the oxygen of the atmoſphere, which combines with the carbon reſulting from the alkaline combuſtion. It even agrees pretty well with theory, in terminating the proceſs of bleaching, to immerſe the cloth and thread in ſour milk, acidulous liquors, or, what is more convenient, very weak ſulphuric acid.

In proportion as the alkali, during the firſt immerſion, deſtroys the colouring matter, the oxygen of the atmoſphere, or that furniſhed by the oxygenated muriatic acid, joins that carbonized matter, and forms carbonic acid, which afterwards reſolves itſelf into gas. This is contained the more in the principles, as the baſes of all the acids are inſoluble in water; but when the combination takes place between the carbon and the oxygen, it immediately becomes ſoluble. Thus, on the one hand, to burn the colouring matter, and to diſſove it on the other, form the whole ſecret of the art of bleaching; and the greater or leſs tendency of vegetable ſubſtances to experience that combuſtion conſtitutes the gradations of their whiteneſs, and the facility or difficulty of bleaching.

The ſlowneſs of the old proceſſes aroſe, in a great meaſure, from bleachers being unacquainted with theſe principles. A long ſucceſſion of leys, and expoſure on the graſs, was neceſſary to penetrate the fibres of the linen from ſtratum to ſtratum. The texture was ſufficiently cloſe to reſiſt the action of the heat of a common ley; and a conſiderable time was required to abſorb the oxygen preſented by the delicate ſtratum of atmoſpheric air.

In the proceſs of bleaching by ſteam, theſe difficulties are removed. The high temperature of the ſteam in the interior part of the apparatus ſwells up the fibres of the thread or cloth; the pure alkali, which riſes with the elaſtic fluid, ſeizes with avidity on the colouring matter, and burns it: ſeldom does the tiſſue of the flax or hemp reſiſt the penetrating effect of this vapour bath. The whole matter, therefore, by which they are coloured is attacked and decompoſed by this ſingle operation; and even if we ſuppoſe that a part has been able to reſiſt, nothing is neceſſary but to repeat the operation, after a previous immerſion and expoſure on the graſs, to inſure its complete effect. The alkali even appears to have a much

a much livelier and more cauſtic action, when it is combined with caloric, than in ordinary leys, where the temperature never riſes above 162° F.: for a ley of one degree of ſtrength, at moſt, by the areometer, is ſufficient for the ſteam apparatus, and, in general, half a degree will be enough. By making the cloth or thread paſs through one ley of oxygenated muriatic acid or oxygenated muriate of lime, an union is effected between the ſolution and the carbon ariſing from the burning of the extracto-mucous matter of the flax; carbonic acid is formed; the water, even, in which this new compound is diluted concurs to promote this combination: if the cloth be then expoſed on the graſs, the carbonic acid is diſſipated, and the cloth is bleached.

It was believed that the ſteam of a pure alkaline ley would not be cauſtic, and would not produce the ſame effects as the ſaline ſolution; and the reaſon aſſigned for this opinion was, the concentration of all the ſalts by the evaporation of the aqueous fluid: but what takes place in the open air, where the atmoſphere every moment abſorbs the moiſture which is evaporated, cannot be applied to a cloſe apparatus, where the temperature is elevated in an extreme degree: beſides, the caloric always carries with it a little alkali even in low temperatures, as is obſerved when water is poured over potaſh; the ſteam which iſſues from it changes blue vegetable colours green.

It is aſſerted that in India cloth is bleached by the ſteam of lime water, and that the Indians brought to France by admiral de Suffrein employed this method. To us, however, it would appear very ſtrange, if it really ſucceeded, that it ſhould have been ſo long neglected. In theory, we find nothing that can warrant ſuch an operation, except that the vapour, which iſſues from quicklime when ſlaked, changes the colour of vegetables expoſed to its action: on this account alone the fact deſerves to be put to the teſt of experiment.

It follows, from theſe chemical principles, that the action alone of ſteam does not bleach, and that the concurrence of oxygen is neceſſary to aid the compoſition of the carbonic acid: this acid requires for its formation 28 parts of carbon, ſaturated with 72 of oxygen; but all the oxygen contained in the apparatus would not be ſufficient to ſaturate the conſiderable quantity of colouring matter burnt by the alkaline combuſtion and converted into carbon: this deficit muſt be ſupplied by immerſion in any oxygenated liquor whatever, and the diſperſion of the elaſtic fluid thus formed muſt be then facilitated by expoſure on the graſs.

I ſhall now proceed to the various manipulations to which

raw cotton cloth and thread ought to be ſubjected in order to bleach them by this new method; and I ſhall begin with that of Chaptal, whoſe apparatus I have before mentioned.

The cotton, diſpoſed in handfuls, muſt firſt be impregnated with a ſlight ſolution of ſoda rendered cauſtic by lime. This operation is performed in a wooden or ſtone trough, in which the cotton is trod down by means of the feet covered with wooden ſhoes. When the alkaline liquor has uniformly penetrated the cotton, it is put into the boiler, and piled up on the wooden grate before mentioned; the redundant liquor runs through the bars into the copper boiler, and forms a ſtratum of liquid, which permits the maſs to be heated without any danger of burning either the cotton or the metal. To form the alkaline ley, Alicant ſoda equal to a tenth of the weight of the cotton ſubjected to the operation is employed; and in a boiler ſuch as that the dimenſions of which I have given, about 800 pounds of cotton may be put at one time. The ley is generally of two degrees by the areometer. As ſoon as the cotton is introduced into it, and arranged in the boiler, the upper aperture is ſhut with its uſual covering, ſcarcely any opening being left, that the ſteam developed by the fire may aſſume a much more conſiderable degree of heat, and react with force on the cotton. When every thing is arranged, the fire in the furnace is kindled, and the ley is maintained in a ſtate of ſlight ebullition during thirty-ſix hours. The apparatus is then ſuffered to cool, and the cotton being taken out is carefully waſhed; after which it is expoſed on the graſs for two or three days, extending it on poles in the day-time, and ſpreading it out on the graſs during the night. The cotton will then have acquired a high degree of whiteneſs; and if any portions of it be ſtill found coloured, they muſt be put into the boiler for a ſecond operation, or be left on the graſs ſome days longer. Theſe ſhades in bleached cotton ariſe, in particular, from all the parts of the cotton in the firſt operation not having been completely and uniformly impregnated with the ley. They may be owing alſo to the cotton, when arranged in the boiler, having been too much accumulated on certain points. When it is judged that the ley has been exhauſted by ebullition, the boiler is opened, and the dried cotton is moiſtened with a new quantity of the ſolution of ſoda: without this precaution it would be in danger of being burnt. It may be eaſily conceived, by an eſtimate of the matters and time employed in this operation, with how much ſaving of expenſe it is attended: cotton is bleached by this method in all the manufactories of the ſouth of France, where it is uſed, at the low rate of two ſols per pound.

To

To bleach cloth, it muſt be immerſed in the ſame manner in a ſlight alkalino-cauſtic ſolution marking two degrees by the areometer. I here ſuppoſe that the cloth has been ſubjected to the neceſſary preparations to free it from the dreſſing, according to the inſtructions I gave when ſpeaking of flax and hemp.

While the cloth is immerſed, and impregnating itſelf with the alkaline liquor, the boiler is filled to the height of a foot with a ley of equal ſtrength. This may be done by means of a bent leaden funnel; but the door is large enough to pour it in, by taking it up from the tub with buckets: the workman then enters the apparatus, and fixes the end of a piece of cloth, with packthread, to one of the arms of the furtheſt reel A, fig. 1. (Plate V.) while another workman without turns it till the whole piece is rolled up: he then fixes a ſecond piece, tacking it to the former, if this operation has not been done before; then rolls it up, and continues in this manner till eighteen or twenty pieces are rolled up. He then throws the extremity of the laſt piece which remains over the roller B, near the arch; conveys it under the two lower rollers C, D, in the copper E E E; then makes it paſs over the other roller F, placed near the arch of the apparatus; and at laſt fixes it to one of the arms of the reel G. The workman aſcertains the height of the liquor in the inſide by means of the regulator H, and immediately ſhuts the cock; after which he ſurrounds the door K with old rags or tow, and fixes it ſtrongly in its place by ſcrews, which ſerve to check and prevent the eſcape of the ſteam. The fire being kindled, and the heat increaſed to that of boiling water, the workman winds up the cloth, beginning with that reel which was empty, until it is entirely charged with it; he then lowers the cranks of the rollers C, D, to immerſe the cloth in the boiling liquor, ſpeedily winds it off, rolling it up on the reel which has been emptied, unhooks the lower rollers, and winds back the cloth in another direction without immerſing it in the liquor. At the end of two hours, more or leſs according to the fineneſs of the ſtuffs, the alkali carried up by the caloric will have completely penetrated the fibres of the cloth, ſwelled by the extraordinary heat of the ſteam. The fire is then ſlackened; and when the apparatus is ſufficiently cold the door is opened, and preparation is made for immerſing the cloth in the oxygenated muriate of lime *. Care muſt be taken, in order to ſhorten the manipulation, to charge in the laſt winding the reel near the door:

* The cloth ought not to be immerſed till after it has been waſhed.—*Note of Chaptal.*

the end of the cloth is then unlooſed, and it is fixed on the arms of one of the reels of another immerſing tub, and it is then unrolled till the whole that was in the apparatus is drawn out: the extremity of the laſt piece is then placed in ſuch a manner as to paſs over the ſeven rollers of the immerſing tub, as is ſeen in the ſection of that veſſel, (ſee Plate II. fig. 3. given with Number XXXVIII.) in order to expoſe as much ſurface as poſſible to the liquor; and being fixed to the ſecond reel, the cover is carefully adjuſted, and the oxygenated liquor is introduced by means of a leaden funnel which paſſes through the aperture of the cover, and which proceeds to the bottom of the tub, to prevent the acid gas from being diſperſed by agitation. After ſeveral windings, a little of the liquor is taken up to examine its degree of exhauſtion; it is then drawn off, and the pieces being taken out ſeparately, they are carried to ſome ſtream to be well rinſed: they are next expoſed on the graſs for three or four days, at the end of which they will have acquired a high degree of whiteneſs. In the laſt place, to terminate the operation, they are made to paſs through very dilute ſulphuric acid.

This operation, which is very expeditious, will be ſufficient for linen and cotton cloth; but if hemp or linen cloth ſhould retain a yellow tint, ſtill neceſſary to be deſtroyed, a ſecond alkalino-cauſtic vapour bath, and two or three days on the graſs, will be ſufficient to give them the requiſite degree of whiteneſs.

For bleaching thread as well as hoſiery, and the like, an apparatus furniſhed with frames may be employed, (Plate V. fig. 2. and 3.) following the ſame proceſſes as for ſtuffs. The frames (fig. 3.) keep theſe articles at a ſufficient diſtance from each other to make them be penetrated by the ſteam in every part; but as they cannot be lowered into the ley to moiſten them, as is done with ſtuffs, by means of cranks and rollers, the operation is ſtopped at the end of two hours ebullition. The upper frame is then well drenched with ley, which, oozing through, ſucceſſively moiſtens the articles placed on the lower frames. The ebullition is again begun, and continued for about four hours. The immerſion is performed in an apparatus ſimilar to that of Rupp, in which the thread and hoſiery are ſuſpended to the upper end of the reel, which in this caſe ſtands vertical, to renew, by a rotary motion, their ſurfaces of contact, and expoſe them to the action of the acid. After immerſion they are rinſed; they are then expoſed on the graſs as in the preceding operation, and they are made to paſs through dilute ſulphuric acid.

In

In manufactories of printed cottons, when it is intended to print various figures by means of mordants, they are made to paſs through madder, and a combination is formed between the mordant or *baſe* and the colouring matter *. The alum uſed by calico printers is applied to the cloth by means of blocks: after it has been diſſolved, by a proceſs foreign to this memoir, in vinegar (acetous acid), it ſuffers to be depoſited on the ſtuff the earthy *baſe*, and thus renders it proper for combining with the colouring matter; the ſtrong affinity which exiſts between that matter and the *baſe* (mordant) cauſes the cloth, when it paſſes through the madder, to aſſume different ſhades: however, as ſome of the colour adheres, though weakly, in the places deſtitute of the baſe, it muſt be removed by repeated boilings with bran or cow's dung, and expoſure on the graſs.

As one of the properties of the oxygenated muriatic acid is to brighten colours, its agency has been employed in various caſes. The proceſs of bleaching by ſteam makes no change in the old diſpoſitions, but only ſhortens the labour, eſpecially when its action is combined with oxygenated liquors.

After being made to paſs through madder, and lying for a ſhort time on the graſs, the cloth is expoſed to the vapour bath; then immerſed in very dilute oxygenated liquor; and, in the laſt place, expoſed on the graſs again. Great care is taken to rinſe it well, in running water, after each operation, and to waſh it well by means of the uſual machinery.

If this method ſhould be adopted in paper manufactories, the following is the manipulation I would recommend: The brown or crude rags ought firſt to be picked and ſorted; they ſhould then be ſlightly triturated with a cylinder, or with a peſtle if the former is not employed; this coarſe pulp ſhould then be immerſed in a cauſtic alkaline ley of three degrees, and carried thence to the ſteam apparatus: it ought to be placed on frames covered with canvas in ſtrata of about an inch in thickneſs, and the frames for this purpoſe may be placed at

* The word *mordant* ought to be entirely baniſhed from the language of the arts, ſince it is as nonſenſical as the expreſſion *oil of vitriol* is abſurd when employed as the ſynonyme of ſulphuric acid. The dyers formerly employed ſaline ſolutions, in which they immerſed their ſtuffs, thinking that the action of this ſalt ſerved to bite, as it were, the ſubſtance of them, and to enlarge their pores, and, according to this idea, they gave them the name of *mordants* (or biters). At preſent, when theſe effects can be better explained, it is much to be wiſhed that the word *baſe* were ſubſtituted for *mordant*, adding ſome epithet to denote the ſubſtance which forms it. We know that theſe baſes in general are the earth of alum (argil or alumine) and white oxide of tin.

a pro-

a proportional diſtance from each other. After the ſteaming it muſt be immerſed in a ley of oxygenated muriatic acid, and ſhould be then put into bags to be rinſed in running water: it is next to be expoſed to the light, ſpread out on large ſheets: in the laſt place, it muſt be made to paſs through ſulphuric acid, and the matter will then have acquired the moſt beautiful degree of whiteneſs poſſible to be given to it.

The property which the oxygenated muriatic acid has, when in the ſtate of gas, of expelling the carbonic acid from its ſaline combinations, a property which it does not poſſeſs in the liquid ſtate, gives reaſon to believe, that if the pulp, after being ſubjected to the vapour a ſecond time, were expoſed in an apparatus or chamber where it might be ſubjected to the action of the gas, the carbonic acid (formed by the carbon ariſing from the burning of the colouring matter in the firſt ley, and by the oxygen which combined itſelf to it during the immerſion in the oxygenated liquor,) would be expelled from the combination which might have been formed during the ſecond ley, and the rags would be immediately bleached without having recourſe to expoſure on the graſs. In all caſes it muſt be obſerved that this proceſs preſents an incalculable advantage, by pointing out the means of employing the coarſeſt and dirtieſt cloth and rags to be converted into pulp of the firſt quality: beſides, this proceſs combines œconomy with ſpeed. It is to be remarked, that in uſing two leys it is of eſſential importance to rinſe the rags when taken from the firſt: their fibres are then more relaxed, and their diſtenſion permits the water to carry away and diſſolve the dirt and colouring matter attacked by the alkaline vapour: in the laſt place, they muſt be made to paſs through acidulous water in order to expel, by the action of ſulphuric acid, the acid of the oxygenated muriate of potaſh from its combination with the alkali. I muſt here alſo call the attention of the intelligent manufacturer to the employment of the refuſe ariſing from the beating and heckling of hemp and flax: theſe ſubſtances, treated by this method, would furniſh valuable materials for the fabrication of paper.

The reader will recollect that, about eight years ago, a propoſal was made for regenerating old paper by employing it again in the manufacturing of new. This proceſs, which has been repeated with ſucceſs, was neglected in France, while it was received with intereſt in foreign countries. At preſent we muſt aſſert our right to this diſcovery, and prove the poſſibility of rendering it uſeful by employing the effect of the alkalino-cauſtic vapour.

When

When the old paper, ſoiled, has been expoſed, in an apparatus with frames, to the action of the ſteam of boiling water alone for twelve hours, it is ſubjected to ſlight trituration under a cylinder; it is then immerſed in a ſtrong alkalino-cauſtic ley; it is well pounded in the tub, that it may be ſtrongly impregnated; and it is introduced a ſecond time into the apparatus, the boiler of which muſt alſo be filled with the ley. The pulp, after being expoſed to a vapour bath for ten or twelve hours, is taken out and preſſed, that the alkaline liquor which runs off may not be loſt: it muſt then be put into bags to be beaten, and rinſed in running water; after which it is ſubjected to trituration under the cylinder till it has acquired the proper degree of whiteneſs. If it be neceſſary to give the utmoſt brilliancy to the white, it will be ſufficient to employ a ſecond vapour bath, together with a ſlight immerſion in the liquid oxygenated muriate of lime; then to rinſe it, and to make it paſs through acidulous water. In this operation it is to be wiſhed that mallets and ſtampers were employed rather than cylinders, which are liable to be attacked by the alkaline liquor. I do not here ſpeak of writing paper, becauſe it is fully proved that this proceſs is too tedious and expenſive.

Ley of Acidulous Water.

At all bleach-fields it is cuſtomary to terminate the operation by making the cloth or thread paſs through acidulous water. In ſome places ſour milk is employed; but almoſt every where at preſent, after the example of the Iriſh bleachers, nothing is uſed but dilute ſulphuric acid. The proportion, in general, is one part in a hundred of acid diluted in water. In Ireland the bleachers ſometimes judge of the proportion by the taſte; but this practice is liable to much error. The tub in which the articles are made to paſs through acidulous water is in general conſtructed of wood; but the operation being much accelerated when performed warm, I would propoſe that the heat, which is generally loſt, ſhould be turned to advantage. By making the heat to circulate in a flue below the leaden veſſel, (already mentioned in ſpeaking of the apparatus of Bawens,) a temperature ſufficient to heat it may be obtained. Hoſiery and thread ought to be immerſed and worked in handfuls for twelve hours: they are then to be rinſed in a large quantity of water, and made to paſs a ſecond time through the acid: ſeveral immerſions brighten the whiteneſs, and I would recommend them in preference to the bad practice of leaving the matters immerſed for ſeveral days. Stuffs muſt be wound up. This is

an

an excellent method, as it completely renews the ſurfaces, and calls forth the whiteneſs in a more uniform manner. When it is requiſite to render the cloth fit for certain markets, it is neceſſary to give it a blueiſh tint, which is done by diluting a little indigo in water till the wiſhed-for ſhade is obtained.

CONCLUSION.

A plain compariſon of the proceſs of bleaching by ſteam with the others above deſcribed will prove its great ſuperiority in regard to ſaving of time, materials, fuel, and manipulations, independently of the advantage of not injuring the ſtuffs: but there is ſtill an application of this principle highly important, which concerns all claſſes of ſociety—I mean the bleaching of linen. Here no other agent is required than the mere action of ſteam; an agent much more powerful and more efficacious than the leys and ſoapy water employed by waſherwomen. This proceſs preſents alſo the invaluable advantage of preſerving the linen longer, as it is not neceſſary to rub it with violence, which is done in the uſual manipulations merely to ſave ſoap and aſhes. An apparatus ſimilar to that at Troyes, on the frames of which the linen might be placed, and then expoſed to the ſteam of ley of a *fourth* of a degree only, would be ſufficient to diſſolve completely the impurities with which it is charged; and by then rinſing it in running water, or in water ſlightly ſaponaceous, all the dirt would be removed, and complete whiteneſs obtained.

It belongs to public functionaries to adopt this proceſs, and to apply it in hoſpitals and other eſtabliſhments, where it would be attended with a conſiderable ſaving.

I ſhall obſerve before I conclude, that experience muſt decide whether the apparatus I propoſe for bleaching woollen cloth and ſtuffs by the vapour of ammonia, might not be employed as well as the other kinds of apparatus for bleaching linen cloth. The condenſed ſteam, by again returning into the boiler, affords the means of totally exhauſting the ley, and of uſing the very laſt portion of the alkaline ſubſtances.

Further Explanation of the Apparatus.

The apparatus employed in Ireland for preparing the oxygenated muriatic acid, and the oxygenated muriate of lime, (ſee Plate IV. loweſt figure) is as follows:

a the aſh-hole; *b*, place for the fire; *c*, the door for the fuel; *d*, entrance of aſh-hole, where a regiſter is poſited to regulate the draught of air; *e*, a caſt iron boiler, in which is placed a leaden alembic, *g g*, on an iron trivet *f*; *h*, a glaſs

or

or leaden bent funnel for introducing the ſulphuric acid; *i*, a leaden cover luted to the neck of the alembic, and pierced with three holes to receive the funnel *h*, the handle of the agitator *k*, and the tube *l*, of three inches aperture, which ſerves to conduct the acid gas into the reſervoir *m*, which performs the office of a Wolfe's bottle: the tube *l* deſcends through the firſt aperture *m* 1 to the bottom of the reſervoir, which to two-thirds of its height is filled with water. In the reſervoir *m*, any ſulphuric acid which paſſes combines with the water, while the oxygenated muriatic acid traverſes the water, and paſſes through the tube *n* into the condenſer *o o*, made of wood, in which is placed an agitator *t*, the arms of which ſtirring the lime water aſſiſts in combining it with the gas in proportion as the bubbles eſcape from the lower extremity of the tube *n*. The tub has ſhelves *q*, *q*, *q*, which ſerve to oppoſe the motion occaſioned by the agitator, and thus accelerate the combination of the acid gas. The covering of this tub is fitted to the ſides of the tub, as expreſſed at *r*. *s* is a ſtop-cock.

Chaptal's apparatus for bleaching, nearly ſimilar to that executed by Bawens. See Plate IV. firſt figure, at the top*.

a the ſtair for deſcending into the aſh-hole *n*; *b* the door of the fire-place *p*. The flame and ſmoke circulate round the boiler *i*, and paſs through the flue *g*, *g*, down under the leaden veſſel *h*, and then back again to the chimney *m*. (See *c c c* the ſecond figure, in which *a* is the ſtair to the aſh-pit, *b* the fire-place, *d d* a winding brick partition to circulate the heat, and *e e e e* the ſolid maſon work.) The *b* (under the arch) is a grate of wood, reſting on the edges of the kettle *i*, containing the bleaching liquor: *e e*, brick work; *e* 1, *e* 1, ſtone work; *q*, a conical ſtone ſtopper, which ſerves as the lid or cover, perforated, and furniſhed with a ſafety valve; the ſtopper is wrapped round with tow or lint to make it ſteam-tight: *f*, a diſcharging cock and a regulator to ſhow the height of the internal liquor; *t*, an iron regiſter in the chimney *m*.

The third figure from the top of the plate is a plan of the apparatus taken on a line with the wooden grate. *a*, the ſtair of the aſh-hole; *e e e*, the brick and maſon work; *f g*, *f g*, the edges of the kettle built into the maſon work; *h*, *i*, the wooden grate over the boiler; *l*, the leaden veſſel.

The other kinds of apparatus have been ſo plainly deſcribed where their uſes have been alluded to, that any further explanation of them here is unneceſſary.

* Part of the impreſſion from the plate was printed off, by miſtake, before the *numbers* were put to the figures: they are therefore referred to in the order in which they ſtand, beginning at the top.

XLIX. *Observations on the Oil extracted from the Female Cornel or Dog-berry Tree, the* Cornus sanguinea *of Linnæus, Class 4th*; Tetrandria Monogynia. *By* C. Marguéron, *of the Hospital for Military Instruction at Strasburgh**.

THE *cornus sanguinea* of Linnæus, a shrub much sought after by gardeners for the sake of ornament, both on account of its figure and of the beautiful red colour assumed by its stem, branches, and leaves, towards the end of summer bears a berry which, when in a state of maturity, has a blackish colour, and of which the utility in medicine as well as in the arts has been hitherto unknown.

The fat and unctuous appearance exhibited by these berries when bruised between the fingers inclined me to think that they might contain an oil possessed, no doubt, of some peculiar properties. Fully persuaded of this truth, that nothing which Nature has produced is useless, I engaged C. Chevreuse, a gardener and botanist at Molsheim, in the department of the Lower Rhine, where this shrub grows in great abundance, to collect a quantity of the berries.

Ten kilogrammes (22 pounds English) were collected and spread out in a barn, not to be dried, but to make them assume a softer consistence: in this state they were reduced to a paste, and subjected to the press. Without the assistance of heat I obtained about two *litres* ($2\frac{1}{8}$ wine pints) of a fat unctuous liquid, having a viscosity similar to that of oil, a green though very bright colour, and perfect homogeneity, as well as all the other physical properties of real oil, and without any disagreeable odour or taste; which determined C. Chevreuse and myself to eat of it in salad, which we did several times without experiencing any inconvenience.

But as these different properties were not sufficient to make this liquid be considered as a real oil, I thought it my duty to subject it to various experiments, of which the following is the result:

A drop of this oily liquid, thrown into a vessel filled with water, extended itself into a very thin pellicle, reflecting the prismatic colours.

Being desirous to know whether it would be possible to deprive this oily product of its green colour, I washed it in cold and hot water, charged with sulphate of alumine (alum),

* From the *Annales de Chimie*, No. 113.

powder

powder of ſlate, pulverized charcoal, &c.: but all theſe means were attended with no effect; the above liquids did not become in the leaſt coloured, and the green colour of the oil ſtill remained the ſame.

Alcohol was alſo employed. As this vehicle aſſumed a greeniſh tint, I thought I ſhould be able by its means to carry off the colouring matter; and I added to a portion of the alcohol thus coloured, a certain quantity of water. The mixture immediately became colourleſs, and ſome drops of oil floated on the ſurface of it. Having evaporated in an alembic another portion of this coloured alcohol, the alcohol I obtained was without colour, and there remained a portion of the oil, having the ſame colour as before: the alcohol, then, was indebted for its colour to a ſolution of a portion of the oil, and not to a ſeparation of the colouring matter.

Sulphur combined perfectly with this oil by the aid of caloric. There reſulted from this combination a real balſam of ſulphur of a dark red colour inclining to brown, and of a very fœtid odour.

Potaſh, ſoda, and ammonia, formed with this oil real ſoap more or leſs ſolid.

Concentrated ſulphuric acid combined with this oil produced a real acid ſoap of a yellowiſh colour, having the appearance of reſin.

The nitric and muriatic acids, cold, had no ſenſible action on this oil, but they aſſumed a ſlight green colour.

The nitric acid heated with this oil made it aſſume a ſolid conſiſtence, and a yellow colour perfectly ſimilar to that of citrine ointment: during the ebullition there was a conſiderable ſwelling, diſengagement of nitrous gas, &c. The theory of this operation being well known, I ſhall forbear ſaying any thing reſpecting it.

Not having been able to procure nitrous acid, it was impoſſible for me to aſcertain the inflammability of this oil with acids.

In boiling this oil for ſome time over litharge, it acquired the drying property which rendered it proper for painting; a property it poſſeſſed before its oxygenation, but in a leſs degree than after it.

By continuing the ebullition the oxide of lead became deoxidated, and was totally diſſolved; the mixture aſſumed conſiſtence, and a brown colour perfectly ſimilar to that of *onguent de la mere.*

The ſame experiment was repeated, taking care to add water, and to ſtir the mixture continually, as is done in regard

gard to *diapalma plaſter*; by which means I obtained an emplaſtic matter of a good conſiſtence, and a colour perfectly ſimilar to that of the plaſter called *vigo cum mercurio*. This colour having induced me to believe that I had failed in my plaſter, which, as I ſuppoſed, ought to be of a whitiſh colour, I ſeveral times repeated the ſame experiment with all the care poſſible, and each time I obtained a plaſter of the ſame colour. The theory of plaſters having been very well deſcribed by C. Deyeux, I ſhall not ſay any thing of it here.

I ſubjected a portion of this oil to the contact of the atmoſpheric air, and found that at the end of ſome time it had aſſumed a little more conſiſtence.

The ſame experiment was repeated, but with the addition of water, taking the precautions preſcribed by Berthollet. At the end of a month the oil had aſſumed a ſolid conſiſtence, and a white colour ſimilar to that of wax.

Being deſirous to aſcertain, in the laſt place, of what uſe this oil might be in domeſtic œconomy, I filled with it a lamp containing a cotton wick, which, when lighted, gave a ſtrong and beautiful light, without ſmoke or any ſenſible ſmell: the ſame lamp, containing a wick of the ſame kind, was ſucceſſively filled with olive oil and rapeſeed oil; the latter laſted two hours, the olive oil two hours and a quarter, and that of the *cornus ſanguinea* two hours and a half.

If we add to theſe different experiments the property which this oily liquid has of not freezing, we ſhall have all the characters of the oil of the *cornus ſanguinea*.

From theſe experiments, the only ones poſſible for me to make, there is reaſon to conclude, that the oily juice obtained by expreſſion from the berries of the *cornus ſanguinea* is a real oil poſſeſſing certain properties which may render it uſeful to the arts, to commerce, and even to medicine. I am of opinion alſo that, according to the principles of Fourcroy, it ought to be placed in the ſecond claſs containing the ſiccative oils, which ſpeedily grow thick, do not become fixed by cold, which inflame by the nitrous acid only, and which, with the ſulphuric acid, form a ſort of reſin.

L. *Re-*

I. *Researches respecting the Laws of Affinity.* By C. Bertholle t, *Member of the French National Institute.*

[Continued from p. 208.]

On Metallic Solutions and Precipitates.

1. In the two preceding memoirs * I considered chiefly those substances which are simple, or of which the composition is not variable; in the present one I shall endeavour to ascertain what influence the degree of oxidation of metals may have on their chemical action, and shall compare generally this action with that of other substances, independently of the properties I have already examined (Art. XIII.).

The solutions and precipitates of mercury appear particularly worthy of attention; for chemists have observed them with more care, and it is more easy to determine their conditions.

2. In the Memoirs of the Academy of Sciences 1790, Fourcroy has described a sulphate of mercury analogous to calomel, that is to say, formed by mercury little oxygenated; and has shown that the sulphate of mercury, particularly when such a degree of heat only is employed as not to produce complete desiccation of the sulphuric acid and mercury, is divided by the action of the water into two sulphates, one of which may be called oxygenated sulphate, and the other mild sulphate. A simple method of obtaining this last combination is to dilute, with an equal volume of water, the sulphuric acid which is treated with mercury, and to boil the mixture: a little sulphureous acid is formed, and, instead of oxygenated sulphate of mercury, that sulphate is obtained of which the properties have been so well investigated by Fourcroy. In determining the constituent parts of the mild sulphate of mercury, he fixes at 0,05 the proportion of oxygen which is combined with the mercury; and supposes that, on decomposing this salt by potash, it is pure oxide of mercury which is precipitated. But the metallic precipitates retain a portion of acid which he has neglected; I therefore believe that in his experiment the proportion of oxygen ought to be rather greater than that which he establishes. In many recent determinations made by chemists, this consideration has been overlooked; which renders them, in some measure, uncertain. The mild sulphate of mercury forms a permanent

* The article on this subject, given in our last Number, constituted the author's second memoir.—Edit.

combination, which is not decompoſed by water as the oxygenated ſulphate of mercury is, upon which I ſhall proceed to make ſome obſervations.

If the proceſs indicated by Fourcroy be employed, a white maſs is obtained, compoſed of ſweet ſulphate and oxygenated ſulphate. By the careful method of waſhing which he points out, the exceſs of acid that maintains the ſolution may be ſeparated from the oxygenated ſulphate and a portion of the mild ſulphate. When the operation is carried further, or when a ſufficient degree of heat is applied to the mild ſulphate, a greater quantity of ſulphureous acid is diſengaged, the mercury becomes too much oxided to form the mild ſulphate, and the combination is found entirely in the ſtate of oxygenated ſulphate, which varies in the quantity of ſulphuric acid which it retains. Let us examine it in the ſtate it poſſeſſes when the operation has been carried to dryneſs, in which, conſequently, it may be conſidered as not poſſeſſing an exceſs of acid.

In this ſtate water cauſes a ſeparation; the maſs which was before white, turns yellow; the liquid becomes very acid, and holds a part of the ſulphate in ſolution; there is formed what has been called, ſince the time of Rouelle, a ſalt with exceſs of acid, and a ſalt with the leaſt portion of acid: but the proportions of theſe two combinations vary, 1. According to the quantity of acid the firſt combination had retained; 2. According to the quantity of water employed: 3. According to the temperature; for the heat concurs with the action of the water.

If for ſimple water an alkaline ſolution be employed, which exerts a more powerful action upon the acid than pure water, two combinations are formed, one of which is found to be almoſt entirely the oxide, and the other in which the acid is for the moſt part engaged: the precipitate obtained differs principally from that which water alone would have produced, by the ſmaller proportion of acid which it retains, and which depends on the degree of concentration of the alkaline liquor which acts upon it.

When the oxygenated ſulphate of mercury retains a more conſiderable exceſs of acid, the action of the latter may be ſo weakened by the water, that no ſeparation will take place.

3. I have hitherto ſuppoſed but two ſulphates of mercury to exiſt, one with the ſmalleſt poſſible proportion of oxygen, and the other with the greateſt; but it is manifeſt that two extremes only are thus fixed, ſo that they may contain within their limits all the other degrees of oxydation: the properties

of

of these intermediate combinations differ so much as to leave no room for the determination of their particular properties, unless both the degree of oxydation and the proportion of the acid be known.

What I now observe as to the intermediate degrees of oxidation must also be applied to the other metallic salts, such as the sulphate of iron, in which there are likewise only two fixed terms, that of the weakest and that of the strongest oxidation.

4. Bergman had before discovered that a solution of mercury by the nitric acid made in the cold, has different properties from that which is prepared by means of heat; and, in his excellent treatise on the analysis of waters, he remarks, that the former does not so readily afford a precipitate with the solutions which contain sulphuric acid, and that the precipitate it forms is white, whereas that of the solution made with heat is yellow; that the first then forms mild sulphate of mercury, which is white, and more soluble in water than the oxygenated sulphate, while the latter forms the oxygenated sulphate.

When nitrate of mercury is prepared by means of heat, some nitrous gas is at first disengaged; but when the disengagement is complete, the mercury is perceived to be dissolved, with the production of scarcely any nitrous gas. I am indebted for this observation to C. Gay, a young chemist of the Polytechnic School, who adds much sagacity to considerable zeal. We see, therefore, that by means of heat an oxygenated nitrate is formed, which, if the operation be not stopped, afterwards combines with mercury, as in another operation the oxygenated muriate of mercury combines with a fresh quantity of this metal*. But in the fluid nitrate of mercury, there are no determinate proportions between the mercury most oxygenated, and that least so: it appears that all the intermediate proportions may exist, as I have observed with respect to the sulphates.

When nitrate of mercury is precipitated by muriate of soda, mercurial muriates are obtained, which differ according to the oxidation of the mercury. With the nitrate a little oxided a white precipitate is obtained, which retains a part of the nitric acid, and cannot be dissolved in the muriatic acid, nor

* Fourcroy has shown that the oxygenated sulphate of mercury, submitted to ebullition with water and mercury, acts also upon the metal; it must therefore pass to the state of mild sulphate. The corrosive mercurial muriate, when dissolved in water, does not act upon mercury; but by trituration with mercury without water, it begins to combine with it, and to impart its oxygen: the combination becomes uniform by sublimation.

be taken up by the concentrated nitric acid, without giving out much nitrous gas. From the solution prepared by heat, a precipitate is obtained rather of a yellow colour, which is not soluble in muriatic, but readily dissolves in nitric acid, giving out a little nitrous gas. The supernatant fluid affords by evaporation a little corrosive mercurial muriate.

If this experiment be made with a nitrate so prepared that the mercury shall be in the most oxided state, and which has not redissolved any metallic mercury, and if it be diluted with a considerably large quantity of water, no precipitate is formed, but all the mercury is found in the state of corrosive mercurial muriate: it is obtained in this state, however, only but in a small quantity, and sometimes even none is had, according to the proportion of muriate of soda employed, because the corrosive mercurial muriate has the property of forming with the nitrate of soda a quadruple salt. This salt is capable of forming rhomboidal crystals, grooved on their face, of a considerable size: it fuses upon red-hot coals; by exposing it to a sufficient heat in a retort, all the mercury is separated in the form of corrosive mercurial muriate. The residue is a nitrate of soda which retains a little muriatic acid, so that the separation which takes place is decided by the respective volatility of the substances, and by a difference of affinity between the nitric acid and the muriatic acid for the oxide of mercury. After the crystallization of this salt, another is obtained in small needles, which appear to be a complex salt, in which the oxide of mercury is found in a greater proportion.

Nothing certain can be determined as to the results of the mixture of the nitrate of mercury highly oxided, and the muriate of soda, because they vary according to the proportions of the substances which act.

I deduce from the preceding observations, that the nitric solution of mercury may hold this metal in solution from the lowest degree of oxidation to the highest, or to that which is required for the constitution of corrosive mercurial muriate; that it may possess it in all the intermediate degrees, but that its properties will be different according to the degree of oxidation.

5. Fourcroy lays it down as a principle, that any metallic oxide whatever gives to acids a colour similar to that which it has itself; whence he concludes, that when a mercurial precipitate which proceeds from a white salt acquires another colour, a change must have been made in the oxidation. This opinion does not appear to me to be well founded. I took some muriatic acid and dissolved in it some red oxide of mercury;

mercury; the ſolution was eaſily effected, without any diſengagement either of oxygen gas, or oxygenated muriatic acid: it ſpontaneouſly afforded fine cryſtals of corroſive mercurial muriate. I may here remark, that this proceſs appears to me to be the moſt ſimple and the leaſt expenſive for the preparation of the corroſive mercurial muriate. The combination which I had formed contained the red oxide of mercury with all its oxygen; yet it was colourleſs: with ammonia it would have given a white precipitate, and with lime and the alkalis a precipitate more or leſs orange coloured.

The red oxide of mercury readily diſſolves in the nitric acid without any diſengagement of oxygen: this ſolution cryſtallizes and forms a white ſalt; but if there be not a ſufficient exceſs of acid, it gives with water alone a white precipitate; with a greater quantity of water recently diſtilled, a yellow precipitate; with lime and the fixed alkalis, a precipitate of a much deeper yellow colour. A coloured oxide may therefore form white ſalts, and afterwards aſſume other colours, without undergoing any change in its oxidation.

6. It is known that the muriatic acid has a greater diſpoſition to combine with highly oxided metals than the nitric and ſulphuric acids. Fourcroy applied this conſideration with advantage to explain ſeveral phænomena. He thus expreſſes himſelf: (*Mem. de l'Acad.* 1790, p. 381.) "Every acid requires quantities of oxygen in the metals in order to combine with them; the muriatic acid, in general, does not combine with thoſe metals, unleſs they be much loaded with this principle, or highly oxided: the mercury appears to be more oxided in the corroſive muriate than in the nitrate." I ſhall take the liberty to make ſome obſervations on the principles laid down by my learned colleague.

It does not appear correct to ſay, that each acid requires different quantities of oxygen in the metals to combine with them; the nitric, the ſulphuric, and the muriatic acids, form combinations with mercury, from the leaſt to the moſt oxided terms; and it is the ſeries which reſults in the muriates which makes the principal difference in all pharmaceutical preparations, from the corroſive ſublimate to the mercurial panacea; but there is this difference, that the combination of the ſulphuric acid and the nitric acid with highly oxided mercury is much weaker, and more eaſily decompoſed, even by the action of water, than that of the muriatic acid, which preſents a very permanent conſtitution. If we turn our attention to thoſe metals which have the property of aſſuming large proportions of oxygen, ſuch as iron, tin, antimony, &c. we ſhall find the ſame properties with regard to the ſulphuric,

nitric, and muriatic acids; so that the action of the two first, which diminishes in proportion as the oxidation advances, is sometimes so much weakened, that they abandon entirely, or are incapable of dissolving some very oxided metals: on the contrary, the muriatic acid dissolves them and holds them in solution, so that it cannot be perceived whether its action be weakened, or whether, on the contrary, it be not increased by a greater oxidation. A probable explanation may be given of this. Sulphur and azote, the bases of the two former, are saturated with oxygen, so that their resulting affinity for the substances that are also greatly oxygenated is very weak; but the muriatic acid, which appears to have in its constitution only a very small portion of oxygen, ought to have a much greater disposition to combine with oxygenated substances.

7. In the foregoing observations I have supposed that the different alkalis share the acid of a metallic solution with the oxide which is precipitated. I speak not of precipitates by ammonia, which in some circumstances is decomposed, and by that means changes the constitution of the precipitate, as has been particularly shown by Fourcroy; but this property is subject to modifications which demand particular attention. Bayen's experiments have ascertained that the precipitates of mercurial nitrates and muriates retain a greater or less portion of acid, so that, on exposing the precipitates of the mercurial nitrate to a sufficient heat, some nitrous acid is disengaged; and on making the same experiment on the precipitates of mercurial muriate, a greater or less quantity of insoluble mercurial muriate is sublimed. I shall here add some observations to those I have already made. (Art. XIII. No. 1.)

When oxygenated muriate of mercury is decomposed by the precise quantity of carbonate of soda necessary to effect its precipitation, the precipitate contains muriatic acid, carbonic acid, and oxide of mercury, in excess; so that on exposing the precipitate to the action of heat, carbonic acid gas and oxygen gas are disengaged; nearly half the mercury is reduced to metal, and the rest of the precipitate is sublimed, retaining all the muriatic acid which remained in combination with the oxide, and forming the mercurial muriate observed by Bayen. The liquid over the precipitate affords by evaporation, at first carbonate of soda, and afterwards a triple salt in which soda predominated.

Carbonate of potash presents different phænomena. A small portion only is required to produce a total precipitation in the solution of corrosive mercurial muriate, and the precipitate

pitate obtained does not amount to half the weight of what would be given by the ſame quantity of oxygenated muriate of mercury, precipitated by the carbonate of ſoda. This precipitate, expoſed to the action of heat, gives out carbonic acid, and ſublimes almoſt totally in the ſtate of mercurial muriate, with the leaſt portion of acid; a very ſmall portion only reſumes the metallic ſtate. The liquid that covers the precipitate makes no efferveſcence with the acids; ſo that here the whole of the carbonic acid is combined in the precipitate with the oxide, and a portion of muriatic acid nearly double that contained in the precipitate by carbonate of ſoda. The liquid when evaporated affords a triple ſalt much more ſoluble in water than the oxygenated muriate of mercury: this ſalt cryſtallizes in ſilky needles.

Carbonate of ammonia cauſes an efferveſcence on decompoſing corroſive mercurial muriate, and no acid is found either in the precipitate or in the ſupernatant liquid. The weight of the precipitate conſtitutes nearly five-ſixths of the muriate decompoſed; a diſengagement of ammonia takes place on the addition of lime. When urged by heat, the ammonia is decompoſed, and azote gas only is received. All the mercury is ſublimed without reduction. But in this ſublimate the mercury cannot be as much oxided as in the ſublimation of precipitates obtained by the fixed alkalis or lime, a part of the oxygen having gone, decompoſes the ammonia. The liquid which covered the precipitate contained a combination of oxide of mercury, of muriatic acid, and ammonia.

The precipitation by ammonia preſented the ſame phænomena, except the efferveſcence.

8. By attending to the other metallic ſolutions and precipitations, the character of thoſe of mercury are eaſily diſcovered, as well as the modifications which depend on the particular affections of each oxide; I therefore think we are juſtified in ſtating the following principles:

1. Acids act upon metallic oxides as upon other ſubſtances, in proportion to their maſs; for when a metal has become but little ſoluble or inſoluble, it may be diſſolved by an exceſs of acid, or may form, by means of ſuch exceſs, a more durable combination.

2. When a metallic combination is decompoſed, the alkali or alkaline earth made uſe of, produces a diviſion of the acid in proportion to the energy of its action. When the metallic combination is weak, water is ſufficient to decompoſe it; ſalts with either a maximum or minimum of acid are then formed. In this caſe the metallic oxides follow the ſame laws as other ſubſtances; but it ſometimes happens that the

alkaline base which is added does not assume its share of the acid, but the metallic oxide, on the contrary, divides the precipitate with the acid; as when we form fulminating gold, or the orate of ammonia. Sometimes also the precipitant, the acid, and the metallic oxide, form two complex combinations; one of which is insoluble and the other remains liquid, as we have seen in the decomposition of the corrosive mercurial muriate by ammonia, and in the experiments that I have described (first series, Nos. X. and XI.). In general, but particularly with respect to the metallic solutions, we must not separate in our reasonings the substance employed by the name of precipitant from the liquid in which the precipitation is effected. Attention ought to be paid equally to all the substances present which can possibly form new combinations.

3. Coloured oxides may produce colourless combinations; but on giving out a part of the acid with which they have been combined, their colour will again appear in proportion to the quantity of acid they have parted with; so that this colour is an indication of the constitution thus established, provided the state of oxidation has not been changed by any particular circumstance.

4. Metallic oxides cannot be compared together, unless they are taken in a determinate state of oxidation. All the combinations they are capable of forming vary, not only from this cause, but also from the proportion of acid they retain, when this proportion is not determined by a crystallization. With respect to oxidation there are only two extremes; that of the least and that of the greatest oxygenation, which can be considered as constant; and hence it follows, that the nomenclature can only indicate vaguely, and with great latitude, any metallic combinations in which the oxidation and the proportion of the acid are not determined.

5. The acids do not follow the same order in their affinity relative to the degrees of oxidation. There are some in which the affinity diminishes with the oxidation, such are the nitric and sulphuric acids; in others again it appears to increase, such as the muriatic acid. Hence we may perceive, independently of all the considerations I have mentioned, how little reason there was for classing the affinities of metals for the different acids by considering them as constant forces.

6. The results of the complex affinities of metallic solutions, mixed with other salts, may also vary from the proportion of those salts, conformably to what has been observed (*on the influence of proportion in the complex affinities*); so that then the proportion of oxygen in the metallic oxide, that of the

oxide in the ſolution, and that of the ſaline combination brought into action with it, all contribute to the new combinations which are eſtabliſhed.

7. In the chemical action of the metallic ſolutions, the laws which we have eſtabliſhed in that of the other combinations might be admitted, if oxidation did not cauſe a change in the affinity of the metal, either for the acids or for the other ſubſtances, and multiply, as it were, in the metals the property of forming combinations; whence the reſults are often ſo complicated, that though by accurate obſervation we may develop the facts and the circumſtances which determine them, yet they cannot be foreſeen by theory, from the mere conſideration of the known properties, as may be done with reſpect to other ſubſtances, the action of which depends on a ſmaller number of conditions.

8. The ſtate in which oxygen exiſts combined in the metals, has likewiſe an influence upon the properties of the metallic oxides, and of the precipitates compared with each other. Bayen obſerved that ſeveral mercurial precipitates, as well as the red oxide, detonate ſtrongly, though in an unequal manner when expoſed to heat, after having been mixed with ſulphur, and that ſome do not poſſeſs this property; but has not given the reaſon of the phænomenon and the exceptions. It appears to me indubitable, that this property of the oxide of mercury, and of the precipitates in which it predominates, is a conſequence of the oxygen poſſeſſing more caloric than it preſerves in its combination with the ſulphur or in the ſulphuric acid. The ſame thing therefore happens as with the nitrate and oxygenated muriate of potaſh, except that the effect is leſs conſiderable; but in the precipitates of the corroſive mercurial muriate, part only of the mercury can be conſidered as not combined with the muriatic acid, namely, that part which may be reduced into metal by the action of the heat which produces detonation. Such of the precipitates therefore as retain a ſufficient quantity of the muriatic acid to admit only of a ſmall reduction of mercury by the action of heat, cannot produce detonation; and ſuch really are the precipitates by ammonia, by the carbonate of ammonia, and by the carbonate of potaſh.

9. The property diſcovered by Bayen is therefore analogous to the fulminating property of the orate and the argentate of ammonia; but it is not perceptible in the other metallic oxides and precipitates. Hence the oxygen in the latter muſt neceſſarily contain a leſs portion of caloric.

10. The properties which depend upon oxidation vary therefore in each metal on account of the proportions of

oxygen;

oxygen; and thoſe which depend on the ſtate of concentration poſſeſſed by oxygen, conſtitute the leading cauſe of thoſe phænomena which ariſe from the changes of combination in elaſtic ſubſtances. (Art. XIV. Nos. 12 and 15.)

[To be continued.]

LI. *Experiments on the Aſhes of ſome Kinds of Wood by* C. Pissis, *Phyſician at Brionde, in the Department of la Haute Loire* *.

HAVING burnt, during the winter of the year 8, a great deal of poplar as fire-wood, I remarked that the aſhes by being re-burnt on the hearth, formed cruſts of real frit, ſuch as that of the aſhes of ſea-weed, with this difference, that they were only thin and of little extent, having neither been ſtirred, nor received any other heat than that of a moderate fire uſed in a parlour. I firſt ſuſpected I had obtained an extraordinary quantity of potaſh; but as I durſt not venture to aſcribe it to the quality of the wood, as the white kinds of wood have always been conſidered as furniſhing little ſaline matter, the trembling poplar (*Populus tremula*, Linn.) a tree of the ſame kind as our common poplar (*Populus alba*) furniſhing only, when burnt with the greateſt care, 9 drams, 45 grains, of potaſh per quintal of wood, I imagined that it depended on an alteration in the ligneous body. We cultivate the poplar for the purpoſe of obtaining props for our vines, and as it is bad fire-wood, we never cut it till it ceaſes to throw forth ſhoots. It is not uncommon to ſee poplars having the bark and branches exceedingly vivacious, while the trunk is reduced to a few handfuls of vegetable mould.

This idea of the augmentation of potaſh in rotten wood was not perfectly correct, but it will be ſeen that it conducted me to reſults very different from the opinions commonly received. But I ſhall return to theſe theoretic points when I have detailed the following experiments, which will ſerve to illuſtrate them.

1ſt, A hundred parts of dry and ſound poplar wood produced four parts of aſhes.

2d, A hundred parts of dry and rotten poplar wood, but not yet in the ſtate of mould, produced eight parts of aſhes.

3d, A hundred parts of each of theſe kinds of aſhes, lixiviated till the water became inſipid, and completely dried on

* From the *Annales de Chimie*, No. 112.

an

an ignited plate of iron, loſt 28 parts in weight: the firſt waters were very ſtrong.

4th, A hundred parts of the ſame aſhes re-burnt and treated as above loſt only 22 parts: the leys were ſtronger and more cauſtic than the preceding.

5th, A hundred parts of the aſhes of dry and ſound oak, re-burnt and treated as above, loſt 16 parts.

6th, A hundred parts of moiſt mould of oak of an ochre colour, placed on an ignited plate of iron, became dried and incinerated very ſpeedily, and left three parts of aſhes, which, though re-burnt, had the colour of iron filings. This is nearly the double of what a quintal of dry oak gave when burnt with the greateſt care. Theſe aſhes were perfectly inſipid.

7th, A hundred parts of the frit mentioned in the beginning of this paper, treated in the ſame manner as the aſhes of No. 3, loſt 37 parts in weight. This frit appeared at firſt to be inſipid; the potaſh was concealed in it, but, by length of time and trituration, the water carried off a great part of it; yet it is probable that there remained ſome of it in the reſiduum by means of a ſort of vitrification. Theſe leys were very cauſtic.

8th, Some morſels of this frit brought to a red heat in the fire, and quenched in a ſmall quantity of water, furniſhed a ley ſo cauſtic as to convert into ſoap melted wax and tallow, on which the ley was poured cold.

9th, This ley filtered on baked plaſter of Paris (ſulphate of lime mixed with lime) reduced to powder, loſt its alkaline taſte, and furniſhed by ſpontaneous evaporation beautiful cryſtals of ſulphate of potaſh.

It follows from theſe experiments:

1ſt, From the four firſt compared with the fifth, that the wood of the white poplar is richer in ſaline matter than oak: here then we have an exception to an admitted rule, which conſiders hard wood as the moſt abundant in potaſh. The poplar is a wood ſo ſpongy that rats cannot pierce it; the filaments of it reſiſt their teeth in the ſame manner as hemp would do; it is difficult to be ſawn, and is exceedingly ſubject to rot: in order to be eaſily ſawn it muſt be cut when in its vigour, which is never thought of, as I have already ſaid. This wood when dry burns with a white flame, gives little heat, is ſpeedily conſumed, and makes no cinders. It is evident that it abounds more with incombuſtible parts than other kinds of wood; which is the caſe alſo with the willow, which gives a quantity of aſhes twice as great, but only about as much ſaline matter, as the oak; that is to ſay, 15 grammes

(2310 grains Engliſh) per myriagramme (22 libs. 1 ounce) of wood, while the poplar furniſhes 72 (11,088 grains.) To what is it indebted for this quantity? An anſwer to this queſtion will be found by analyzing its ſap. The acrid and viſcous juice of its buds, uſed in pharmacy, will alſo furniſh ſome data.

A myriagramme (22 libs. 1 ounce, avoirdupoiſe) of the *populus tremula* (trembling poplar) furniſhes only 7 grammes (1078 grains) of ſaline matter, as appears by a calculation made from a very accurate experiment*. This difference, more than decuple, in ſaline matter between one tree and another of the ſame ſpecies, will aſtoniſh only thoſe who do not know that the rhubarb and ſorrel are of the ſame genus, and that the ſour cherry belongs to the ſame ſpecies as the common wild-cherry. Nature is not confined to our narrow ideas of analogy. It has been laid down as a principle, that plants of the ſame family may mutually ſupply each others place in medicine, but it is prudent to apply this principle only after a very accurate analyſis of the plant employed, and that intended to be ſubſtituted for it.

2d, It follows from the firſt five experiments, that rotten wood gives more aſhes than ſound wood, often more than double, which may be readily conceived. Wood by rotting becomes ſpongy and light. I have ſeen ſome which weighed a half leſs, under an equal volume, than ſound wood of the ſame tree. It burns without flame like tinder, and is difficult to be incinerated. It appears that the hydrogen has been almoſt deſtroyed, and that the carbon concealed by the earthy parts eſcapes combuſtion. This wood is often phoſphoreſcent, a phænomenon the cauſe of which is yet unknown. Rotten wood muſt not be confounded with that which is pierced by worms. In the latter caſe the wood without changing its colour is reduced to an impalpable powder, and in the ſmall part which remains ſolid is found the oriſice the worm has formed, and often the worm itſelf †. A hundred parts of a vine twig reduced to an impalpable

* *Ann. de Chimie*, vol. xix. p. 178. I did not extract the ſaline matter from the poplar, as the eſtimation by exhauſtion appeared to me more certain, becauſe it is difficult to bring back the ſaline matter always to the ſame point of calcination. But having calculated, that the aſhes of the oak loſes in lixiviation 0·16, and gives in ſaline matter 0·13, I deducted 3·16ths, or 0·19, for the loſs by lixiviation, and I think I obtained nearly the product in ſaline matter, this difference ariſes from the carbonic acid which the ſaline matter loſes in calcination.

† This worm differs according to the wood, the *phalæna cóſſus*, larva of the goat-moth, a delicate morſel among the ancients, which no modern would venture to taſte, is found in old trunks of the oak.

powder,

powder by worms, burnt on an ignited plate of iron, were completely incinerated, and left three parts of aſhes, which is nearly the quantity obtained from a quintal of dry vine twigs burnt with the greateſt care. This wood, which ought properly to be called worm-eaten, has nothing then in common with rotten wood called alſo worm-eaten, but the name improperly applied to the latter.

It has been ſaid, that rotten wood furniſhes little ſaline matter *: this obſervation is correct in regard to wood drenched by the rain; the eighth experiment proves it; but it is proved by the third that wood which has rotted without being drenched by rain, does not loſe an atom of its potaſh, and that taking equal weights, as rotten wood furniſhes a double quantity of aſhes equally rich, it will furniſh a double quantity of ſaline matter. This affords a reſource for manufactories, eſpecially when we conſider the moderate price of this wood, which in general is much neglected.

The aſhes of dead timber, the tops and bark of which being well preſerved have left no place of entrance for rain, may be employed either in leys for domeſtic purpoſes, in ſaltpetre manufactories, or ſalt works. The mould of theſe trees will alſo form an excellent manure, ſince it will have retained all its potaſh. It is thence ſeen, that where the mould has been drenched with rain, vegetation has been benefitted. We know by the experiments of Vauquelin, that the potaſh in the ſap of trees is in the ſtate of acetite: it would be highly gratifying to know in what ſtate it is in the wood and in the mould.

3d, The fourth experiment proves that the aſhes by being re-burnt loſe a fifth of ſaline matter, and this muſt be the caſe ſince it diveſts itſelf more and more of carbonic acid; but by theſe means it gains as much in quality as is proved in particular by the eighth experiment. However, if very rich aſhes, ſuch as that of the poplar, be re-burnt, a frit will be obtained, or a ſemivitrification, which will retain a part of the potaſh: beſides, this frit, in order to be lixiviated, muſt be triturated, which will increaſe the labour. This frit, from which may be extracted 30 per cent. of ſaline matter, and which will then ſtill contain a great deal of it, would perhaps be as proper for glaſs-making as certain kinds of ſoda.

This ſemi-vitreous ſtate, and the firmneſs of the ſoaps obtained in the eighth experiment, induced me at firſt to be-

* *Annales de Chimie*, vol. xix. p. 160. The ſame thing has been ſaid of ſawduſt, and carpenter's chips: this depends on the wood employed, and the manner of cutting or dividing the wood, ſo as not to change any thing in its nature.

lieve,

lieve that the aſhes of the poplar contained ſoda, but the ninth experiment undeceived me. I employed plaſter of Paris, which I had at hand, for want of ſulphuric acid; it is a convenient thing, ſaid Franklin, to know how to ſaw with a gimlet: for the ſame reaſon I uſed wax and tallow.

I ſhall conclude with ſome ideas ſuggeſted by theſe experiments. Melted wax, tallow, and hog's lard, and heated oils, aſſume a degree of heat ſuperior to that of water, and even to that of boiling ley. When an alkaline ley is poured into them, the mixture ſwells up in an extraordinary manner, all the water evaporates in a moment, and with equal proportions of ingredients, the ſoap remains firmer than that made by the uſual proceſſes in manufactories; beſides it becomes dry as ſoon as made. Theſe advantages are worth the trouble of making a trial, and in that caſe the following queſtions ought to be examined:

1ſt, In heating the oil before the water, may not the expanſion which takes place at the time of mixture produce ſome accident?

In my opinion it will not, if the boiler is very deep, and filled only one-fourth.

2d, May the mixture be agitated? Yes, when the whole of the ley has been employed, the mixture then remaining in a ſtate of tranquil fuſion.

3d, Do the ſalts foreign to ſoap, particularly the alkaline carbonates, paſs off with the exhauſted ley? I fear not; in my trials on a ſmall ſcale no liquor remained.

4th, Do not oily bodies too much heated become ſo much altered as to alter the ſoaps? I apprehend they do; my ſoaps were grayiſh.

LII. *Reflections on the Difference between the Acetous and Acetic Acids.* *By* C. Dabit, *of Nantes* *.

BEFORE the memoir of Berthollet on the acetous and acetic acids (*vulgo* radical vinegar) had appeared, chemiſts agreed pretty generally in aſcribing the difference which exiſts between them to a greater concentration on the part of the acetic acid. But ſince the publication of that work, in which the above celebrated chemiſt proves that this difference is owing to ſomething elſe than a greater concentration of the acetic acid, this opinion has been almoſt entirely abandoned. The experiments on which Berthollet ſupports

* From the *Annales de Chimie*, No. 112.

his opinion ſeemed ſo concluſive, that all chemiſts almoſt were eager to adopt it. The pneumatic chemiſts, explaining this opinion in the language of their theory, have ſaid that the acetic acid is the acetous combined with a new quantity of oxygen; conſequently, in a ſtate of more perfect combination. Such has been the opinion hitherto generally adopted.

C. Adet, in a memoir read before the National Inſtitute, and inſerted in Vol. XXVII. of the *Annales de Chimie*, oppoſes this opinion, and maintains:

1ſt, That no ſuch acid as the acetous exiſts.

2d, That the acid of vinegar continually preſents itſelf at the higheſt degree of oxygenation to which it can attain; and conſequently, that it is always in the ſtate of acetic acid.

3d, That the difference which exiſts between the acetic acid extracted from the acetate of copper, and that extracted from vinegar, depends on the leſs quantity of water contained in the latter.

Has C. Adet completely attained the end which he propoſed? In my opinion he has not. In the firſt place, the greater part of the experiments on which the opinion of Berthollet reſts, have not even been attacked, and conſequently remain in full force. Such are:

1ſt, The pungent odour and taſte which this acid retains though diluted with water ſo as to make its ſpecific gravity equal to that of diſtilled vinegar; an odour and taſte which the latter does not poſſeſs.

2d, The property which the acetic acid has of immediately combining with copper, while the acetous acid does not combine with it until it has been oxidated.

In the next place, the proofs which this chemiſt brings to ſupport his opinion, are far from being ſo concluſive as might be wiſhed. C. Adet himſelf allows that they ſtill leave ſome deſiderata.

I propoſed to preſent ſome objections to the opinion of C. Adet, and to prove that it cannot be admitted. I even had written a paper on the ſubject; but C. Chaptal, in his obſervations printed in Vol. XXVIII. of the *Annales de Chimie*, having diſcharged this taſk much better than I could have done, I have thought proper to ſuppreſs the greater part of my labour; I ſhould even have ſuppreſſed it entirely, if the experiments I made, and the reſults I obtained, had not led me to adopt an opinion different from that of Chaptal. It is this part of my labour that I have determined to give.

C. Chaptal, after having proved, by ſeveral experiments, which appear to me deciſive, that the difference between the

two

two acids does not arise from a greater concentration on the part of the acetic acid, concludes by saying:

1st, That there is a difference between the acetous and acetic acid.

2d, That this difference arises from a less proportion of carbon in the acetic acid than in the acetous acid.

3d, That the acetous acid does not pass to the state of acetic acid but by carbonization.

4th, That the difference which exists between that acid and some others equally susceptible of modifications by changes made in the proportions of their constituent principles is, that in this acid the oxygen does not appear susceptible of addition nor subtraction, and that the carbon alone experiences variations and determines all the changes, while in other acids it is the oxygen which varies and occasions the changes.

I am of opinion with Chaptal, that there is a difference between the acetous and acetic acids: I even admit that the latter contains less carbon than the acetous acid; but does the acetous acid pass to the state of acetic acid only by decarbonization, as that celebrated chemist asserts? I do not think so. On the contrary, I hope to be able to prove, by several experiments: 1st, That the difference which exists between the two acids is owing to the different proportions of oxygen: 2d, That this substance is in greater quantity in the acetic than the acetous acid: 3d, That by adding oxygen to the acetous acid it may be made to pass to the state of acetic acid.

C. Adet having laid it down as a principle, that the acid of vinegar, in its combination with potash, is in the state of acetic acid, and, as Chaptal has not disputed this assertion, which, if correct, would give great weight to the opinion of C. Adet, I thought it proper first of all to examine whether, as C. Adet asserts, the acetic acid, obtained from the decomposition of the acetite of potash, by means of sulphuric acid, really existed in that salt, because that chemist says "the acetic acid is obtained before the least atom of sulphureous acid manifests itself," or rather, whether it be not owing to a commencement of the decomposition of the latter acid, as seems to be proved by the sulphureous acid obtained towards the end of the operation. To obtain a solution of this problem, which appeared to me to be of the utmost importance, I thought it would be sufficient to employ an indecomposable acid, which, however, should be susceptible of acquiring a concentration nearly equal to that of the sulphuric acid. As the muriatic acid appeared to me to possess

all

all the requiſite properties, I proceeded in the following manner.

Exper. I. One part of concentrated muriatic acid, and two parts of the acetite of potaſh, were put together into a retort, and diſtilled with a proper apparatus, till nothing more paſſed over; I then unluted the apparatus, and found that the acid obtained was in every thing ſimilar to concentrated diſtilled vinegar; only that it was mixed with a little muriatic acid.

Exper. II. Equal parts of concentrated muriatic acid and oxide of manganeſe in powder, and two parts of the acetite of potaſh mixed together, and ſubjected to diſtillation, as in the preceding experiment, gave me acetic acid, ſimilar in all its phyſical properties to that obtained by ſulphuric acid, except that it was mixed with a little oxygenated muriatic acid which was diſengaged towards the end of the operation.

Exper. III. Acetite of potaſh, mixed with the fourth of its weight of ſulphuric acid, was diſtilled in a ſand bath, in a moderate heat. Acetic acid paſſed at the commencement of the operation, and before the leaſt atom of ſulphureous acid had manifeſted itſelf, as obſerved by C. Adet; but when about the fourth of the liquor which I obtained had paſſed, the ſulphureous acid began to diſengage itſelf, and continued to do ſo till the end of the operation.

It evidently reſults, in my opinion, from theſe experiments, that in the acetite of potaſh the acid of vinegar is not in the ſtate of acetic acid, but of acetous acid, and that an addition of oxygen is indiſpenſable, to convert the acetous acid into acetic. Theſe principles being once admitted, no doubt will remain that the ſulphuric acid may loſe a portion of its oxygen without however paſſing to the ſtate of ſulphureous acid, as I have advanced in my eſſay on the theory of ether, and conſequently that this acid may be in an intermediate ſtate between the ſulphuric and ſulphureous acid*.

* Fourcroy and Vauquelin, in their obſervations on my work reſpecting ether, oppoſe this opinion. It is not on ſuppoſitions, they ſay, that theories are eſtabliſhed, and they add, that I ought to have begun by proving that the ſulphuric acid may loſe a portion of its oxygen, without paſſing to the ſtate of ſulphureous acid. I am ſenſible of the full force and juſtneſs of this objection. I omitted proving this aſſertion, becauſe I conſidered it as an acknowledged principle, which the experiments contained in my eſſay on ether, and that deſcribed in the obſervations of the above chemiſts, only confirmed. Though it is only a ſhort time ſince I received the volume of the *Annales* which contain theſe objections, I have employed myſelf on the means of obviating them, and two experiments which I have already made give me hopes of ſucceeding.

If any doubt ſhould ſtill remain, that an addition of oxygen is indiſpenſably neceſſary to convert acetous into acetic acid, the following experiment muſt, in my opinion, entirely remove it.

Exper. IV. Equal parts of diſtilled vinegar, concentrated by freezing, and of oxide of manganeſe in powder, mixed together and diſtilled to dryneſs, gave me the following products. There firſt paſſed about one half of the vinegar, which had not experienced the leaſt alteration. I then changed the receiver, and the acid which I obtained had acquired the odour which characterizes the acetic acid. When it was thus proved that the addition of oxygen is indiſpenſably neceſſary to convert acetous into acetic acid, it remained for me to examine how the oxygen effects that change,—whether by taking from it a portion of its carbon, as Chaptal ſuppoſes, or rather by combining with it, as the following experiment will prove.

I repeated the ſecond experiment in a mercurial apparatus, that I might collect the carbonic acid gas, which would neceſſarily be diſengaged if the acetous acid paſſed to the ſtate of acetic acid only in conſequence of loſing a portion of its carbon, which in this operation muſt have combined with the oxygen of the manganeſe. When the operation was terminated, lime water did not ſhow the leaſt atom of carbonic acid.

From the above experiments I think myſelf authorized to conclude,

1ſt, That there is a difference between the acetous and the acetic acid.

2d, That this difference is owing to a greater proportion of oxygen in the acetic than in the acetous acid.

3d, That the acetous may be converted into acetic acid, by combining it with a new quantity of oxygen.

4th, That the acid, in what is now called acetate of potaſh, is in the ſtate of acetous acid.

5th, That the acetic acid obtained from the decompoſition of that ſalt, by the means of ſulphuric acid, is owing to a portion of oxygen which it takes from the latter acid.

LIII. *On a cheap Subſtitute for Oil Paint.*

C. Cadet de Vaux has lately publiſhed a memoir, on what he calls painting in diſtemper with milk. His proceſs, which is nearly ſimilar to that of Ludic, given in the firſt volume of this Magazine, is as follows:

Take

Take ſkimmed milk two quarts, lime newly ſlaked ſix ounces, oil of pinks, linſeed oil, or nut oil, four ounces, Spaniſh white (or well-ground chalk) three pounds. Put the lime into an earthen veſſel, and pour over it a portion of the milk, ſufficient to bring it to the conſiſtence of thick ſoup: add gradually the oil, ſtirring the mixture with a ſmall wooden ſpatula; then pour in the remainder of the milk, and dilute in it the Spaniſh white. Skimmed milk, in ſummer, is often found curdled, but this is a matter of little importance to our preſent object; by coming into contact with the lime it will ſoon be reſtored to fluidity. It muſt, however, not be ſour, as it would then form with the lime a ſort of acetite (or, more correctly, a lactite) of lime, ſuſceptible of attracting humidity.

The lime is ſlacked by immerſing it in water, then taking it out and leaving it to effloreſce in the air. The choice of the oils is a matter of indifference; but, for painting white, oil of pinks ought to be preferred, becauſe it is colourleſs; even the moſt common oils may be employed for painting with ochre. The oil, by falling into the mixture of milk and lime, diſappears: it is completely taken up by the lime, with which it forms a calcareous ſoap.

The Spaniſh white muſt be pounded, and ſtrewed gently on the ſurface of the liquid, by which it is gradually imbibed, and at length falls to the bottom. This paint may be coloured like that for diſtemper, by charcoal pounded in water, yellow ochre, &c. It is employed in the ſame manner as paint for diſtemper. This quantity will be ſufficient for giving a firſt ſtratum to ſix fathoms. The expenſe for the above quantity is about four-pence halfpenny, which makes about three halfpence per fathom.

When it is neceſſary that the painting ſhould be more durable, the following mixture may be employed: ſlacked lime two ounces, oil two ounces, and Burgundy pitch the ſame quantity. The pitch muſt be diſſolved in the oil, in a gentle heat, and the clear liquor of the milk and lime muſt be added. During cold weather, the milk and lime ought to be heated, that the pitch may not be too ſuddenly cooled, and to facilitate its union with the milk and lime. Painting with this ſubſtance has ſome analogy to that known by the name of encauſtic.

Theſe kinds of painting will ſtand againſt the common effects of the weather for years, and anſwer well for garden railings, fencings, and the like. The firſt time that wood is thus painted, it ſhould receive a ſecond coat after the firſt one is dry; but when re-painted, a ſingle coat only will be neceſſary.

LIV. *Extract of a Memoir on the Bronze of the Antients, and an Antique Sword. Read in the Public Sitting of the Inſtitute, July 4. By* C. MONGEZ.

C. TRAULLE, preſident of the Society of Emulation at Abbeville, preſented to the claſs of literature and the fine arts, a ſword of bronze, found near Corbie, in the turf-moſs, formed by the depoſits of the Somme. A ſmall figure of a warrior found in the ſame moſs, and ſeveral Roman medals, ſome of which are frequently dug up there, give reaſon to conjecture that this weapon belonged to the Romans; beſides its dimenſions, the blade, being eighteen inches in length and two-edged, together with its point, its ſtrength, its weight, ſeem to characterize a ſword of the conquerors of the world. Though it was found near the ſkeleton of a man and that of a horſe, it ſeems doubtful whether it belonged to a horſeman, becauſe the ſwords of the cavalry were longer than thoſe of the foot ſoldiers. It is alſo probable that it was an object of luxury, or ſerved as a mark of diſtinction to ſome officer, for we know, by the teſtimony of Polybius, that the ordinary ſword of the Romans was of iron. In a word, ſuch a weapon of bronze would coſt at preſent as much money as a cutlaſs of the ſame length. It would, therefore, be no ſaving to adopt the uſe of bronze ſwords, but they could be ſooner manufactured, as they might be caſt; ſo that in a country deſtitute of manufactories for making ſabres and ſwords, twenty thouſand men might be eaſily armed in the courſe of a month.

After having examined the alloy of which the antique ſword is compoſed, I generalized my labour, and made ſome reſearches in regard to the bronze of the antients. The following is the reſult.—We employed copper under the metallic form in three different ſtates:—pure copper; braſs or copper alloyed with zinc; and bronze, that is, copper alloyed with tin. I aſcertained, by different experiments made in concert with Dizé, that we have no remains of pure copper from the antients. The ſheathing even of ſhips, which was known to, and practiſed by them, was not performed with copper, but with plates of lead: the nails only were of bronze. Leo-Baptiſta Alberti obſerved it on an antient ſhip, diſcovered, while ſome reſearches were making under his direction, in the neighbourhood of lake Riccia. If to this be added, that all the antient inſtruments, vaſes, and medals, have been caſt, we may conjecture, that the antients made very little uſe of pure copper.

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The ſame thing cannot be ſaid of the antient braſs. Collections of medals contain ſeveral which have been evidently formed of this alloy, which is known to be factitious, but which Pliny believed to have been a long time before extracted from the boſom of the earth quite formed.

By the chemical analyſis of the medals of various nations, of a poniard, of a ſword, found at Corbie, of nails, &c. all antiques, and of bronze, we have learned that they contained tin and ſome atoms of zinc, but neither arſenic nor iron were found in them. The proportion of tin varies from four thouſandths to thirteen hundredths, one of the nails contained eight hundredths of tin. We know alſo that tin forms a part of the nails uſed for the ſheathing of ſhips, which are driven into the timbers with as much force as is uſed for iron nails. Why did the antients employ bronze alone? It was not becauſe the earth preſented that alloy quite formed, ſince tin mines do not contain a ſenſible quantity of copper, but becauſe they caſt all their inſtruments, and becauſe copper alone, though rendered fluid by an extreme degree of heat, remains in the conſiſtence of a paſte. The addition of tin renders it very fluid, and diſpoſes it to aſſume all the delicacy of the mould. It, therefore, forms a tenth of the metal uſed for cannons, and a fourth of that employed for bells. Beſides, bronze is leſs ſuſceptible of being covered with verdigreaſe than pure copper.

This dangerous effect, however, cannot be avoided when greaſe, acids, and even vegetables, are long kept in bronze. For this reaſon the Romans adopted the uſe of tinning, which Pliny ſays had been invented in his time by the Gauls; theſe people they haughtily treated as barbarians, though they had learned from them the art of working iron, and of making ploughs with ears, &c.

Philo of Byzantium has made us acquainted with another object, which the antients had in view when they alloyed copper with three hundredth parts of tin. It was for the purpoſe of making elaſtic plates, employed in ſhooting darts and javelins from their warlike machines. He adds, that they hammered them a long time to give them perfect elaſticity. This alloy might be employed in our machines, and particularly in carriages for making bronze ſprings, which might be ſubſtituted for thoſe of ſteel, the latter being oft ſhort and brittle. Bronze alſo might be ſubſtituted with advantage for iron in machines, which may be ſuddenly deranged by the iron work breaking, ſuch as axles for carriages, and hinges for rudders. We have already adopted, for fixing the wheels to

the axles, boxes of copper, the models of which were furniſhed by the antiquities found at Herculaneum. It is thus that the ſtudy of antiquity, contributing to the improvement of the arts, will free its followers from the reproach of inutility, which has been ſo often thrown out againſt them by ſuperficial minds.

At the period of the revival of letters, the learned men who examined a great many ſharp inſtruments of bronze, found in the ruins of antient cities, imagined that the antients gave them the hardneſs neceſſary for cutting by means of tempering. Pliny, however, who details all the operations in regard to the working of copper, thoſe in regard to iron, and the method of tempering it, obſerves perfect ſilence reſpecting the tempering of copper: on the contrary, we have ſeen blanks for copper money thrown into cold water, after being ſtrongly heated, to ſoften them. Count Caylus endeavoured to diſcover the pretended ſecret of the tempering of copper. For this purpoſe one of his chemical friends compoſed alloys, that is to ſay, miſtook the method, even if ſuch a ſecret had ever exiſted. By alloying a ſixth of iron with copper he conſtructed a ſword of bronze, which exhibited indeed the form of the antique ſwords, and cut like them, but which conſiſted of a different alloy, exerciſed an action on a magnetic bar, in the ſame manner as different alloys of iron and copper, even to the weak proportion of one part in eighty-one, a term at which the magnetic bar remains motionleſs. But of more than a hundred morſels of antique bronze, medals, ſtatues, knives, poniards, ſwords, &c. which I ſubjected to the ſame proof, not one exibited the leaſt trace of iron. In a word we aſcertained, by very ſimple experiments, that the antient bronze contained no arſenic, though a modern chemiſt has aſcribed to the addition of that ſubſtance the hardneſs poſſeſſed by the cutting inſtruments of the antients.

C. Darcet, the ſon of our colleague, who analyſed the ſword dug up near Corbie, followed the real method for diſcovering the cauſes which gave to that weapon the faculty of cutting, which it ſtill poſſeſſes. At my requeſt he formed a ſimilar alloy with twelve hundredths of tin: by means of a mould he formed two knife-blades, and one pen-knife blade. One of the knives was ſubmitted to the claſs, who found that it was not inferior to our common knives. The edge was formed by hammering, and ſharpening it on a grind-ſtone. It was thus that the antient ſword had been formed, and traces of the hammer may be ſtill ſeen on its edges.

If bronze were employed for cutting inſtruments uſed at

ſea,

ſea, the blades, which the acidity of the atmoſphere ruſts and deſtroys when made of iron, would be preſerved from that inconvenience.

I ſhall terminate this extract with ſome reflections on the price of metals in the time of Pliny. Lead at Rome, during the firſt century of our æra, was worth twenty-four times the price at which it is ſold at preſent at Paris, and tin eight times its preſent price; ſo that lead was three times as dear there as tin, while among us it does not coſt a third of the price. The comparative dearneſs of theſe metals among the antients muſt make us ſenſible of the advantage which more extenſive commerce, and metallurgic labours conducted in a more ſcientific manner, give us over them. But we ought not to forget that this advantage is the reſult of eighteen centuries of experience and improvement; and that, notwithſtanding this great number of centuries, the antients are ſtill our maſters in that part of literature, and the fine arts, which forms the peculiar domain of the imagination.

LV. *On the Expanſion of Wood by Heat.* By DAVID RITTENHOUSE, LL. D. *Preſident of the American Philoſophical Society* *.

IN the preſent ſtate of experimental philoſophy it is well known that bodies in general enlarge their dimenſions, or expand, on being heated, and contract in cooling. From ſome experiments heretofore made, wood has been thought to make an exception to the general rule, and this opinion has ſo prevailed that many curious perſons have applied wooden pendulum rods to their time-pieces, to prevent the variation in their rate of going, ariſing from the expanſion and contracting of a metal rod. From my own obſervations, however, as well as thoſe of ſome of my friends, the wooden pendulum rod does not appear to anſwer the expectations formed on it. I had in my poſſeſſion for ſeveral years an excellent time-piece made for this ſociety by an ingenious workman and worthy member of the ſociety. The reſult of my conſtant attention to this clock was, that, though its regular variations with heat and cold were probably much leſs than thoſe of metal pendulums, it nevertheleſs went always faſter in winter than in ſummer, and was liable to very ſudden and conſiderable variations; ariſing, no doubt, from the combined effects of heat and cold,

* From the *Tranſactions of the American Philoſophical Society.*

moiſture and dryneſs. This determined me to make ſome careful experiments with a pyrometer capable of receiving a piece of wood of the length of a ſecond pendulum. Several years ago I made ſome experiments of this kind, perfectly correſponding with thoſe I have lately made, and which I now communicate to the ſociety.

I took a ſtraight-grained piece of white hiccory, green, for I could not procure any ſeaſoned, its length 39 inches, and about 3-8ths of an inch ſquare. This I placed in my pyrometer, and kept it fully extended by a weight faſtened to a ſtring, going over a pulley. To the pyrometer I applied the tube and glaſſes of a good compounded microſcope, and a micrometer, the value of the ſmaller diviſions whereof I found to be nearly .00053 parts of an inch each.

The rod of wood being placed in the pyrometer, I poured ſand all around it, heated to about 250 of Fahrenheit, which degree of heat I found the wood would bear without ſcorching. On pouring in the hot ſand, the rod expanded very much, but ſoon began to contract, even before the ſand was ſenſibly cooled, which I ſuppoſe aroſe from the hot ſand extracting the moiſture of the wood. It continued to contract as the whole grew cool, ſo that when the rod had acquired its firſt temperature it was near 30 of the above diviſions ſhorter than at firſt. I repeated the operation a ſecond and third time, and had then reaſon to conclude that the wood was nearly as dry as it would become by lying long in a dry air. I now let it cool to the temperature of the atmoſphere, which was 75°, and heating the ſand to 200 only, I poured it around the rod. In a few minutes it expanded 16 diviſions. In half an hour the ſand had cooled to 125, and the rod had contracted 11 diviſions. In an hour more the ſand was 80, and the rod ſhortened full 4 diviſions more, being nearly equal to its length when the ſand was firſt applied. On the whole I conclude, that very dry wood expands with heat pretty regularly, though certainly in a much leſs degree than any of the metals, or even glaſs.

The rod above mentioned having been kept in a dry place for twelve months, I again tried it with the pyrometer, having fixed near one end of it a ſmall graduated ſcale of ivory, 360 diviſions whereof were equal to one inch. This ſcale was viewed with the microſcope, furniſhed with a croſs hair, and I thought this method preferable to the ſcrew micrometer uſed before.

The rod was placed in the pyrometer when the temperature of the air was about 60°. On pouring ſand around it, heated a little higher than boiling water perhaps, it immediately expanded

panded half a division, but in less than a minute it began to contract, and continued to do so for an hour, when I drew off the sand. It was now full 10 divisions shorter than at first, so that it had imbibed a great deal of moisture from the air, which it again parted with to the heated sand. Three hours afterwards, when the rod was cool, I again poured the sand on it, heated as before. It now continued to expand for about three minutes, when its length was increased $3\frac{1}{2}$ divisions, it then began to contract, and became full 3 divisions shorter than when the sand was poured on it. I caused the sand to run off once more, and let the rod cool. Then heating the sand 250° by a thermometer, I poured it on the rod, and in a few minutes it expanded $3\frac{3}{4}$ divisions, it then began to contract slowly, and in 15 minutes it became 2-3ds of a division shorter than at first. On the whole, I concluded that the expansion of wood, in its length, will be irregular, corresponding partly to the warmth, and partly to the moisture of the atmosphere.

LVI. *Observations on the Means of detecting the Presence of Lead in Wine.* By C. O. Reinecke*.

To gratify sordid avarice at the expense of the health of mankind, by communicating to sour wines a fallacious sweetness by means of the oxide of lead, is a crime which for the dignity of the human race we shall suppose to be committed rather through ignorance than want of principle. Half a bottle of Chably wine was lately sent me to test, with a notice, that a person, whose opinion, on account of his talents, was entitled to great respect, had tried this wine, and believed that he had found in it oxide of lead. To accomplish the object in view I employed the following means:

1st, After being assured that the seal with which the correspondent had marked the half bottle was in good preservation, I began to examine the physical properties of the wine it contained. It was perfectly clear, had scarcely any colour, and had formed no deposit. The taste of this liquor alone convinced me that it had not experienced that adulteration of which it was suspected; it had that pure and pungent taste, which is so much liked in Chably wine, without the slightest trace of that perfidious sweetness communicated by acetite of lead, and which always betrays itself by a styptic relish, however small may have been the quantity of this poison mixed with the liquor.

* From the *Annales de Chimie*, No. 114.

2d, As

2d, As it was neceſſary that the detection ſhould be of ſuch a nature as to be evident to thoſe acquainted with the firſt principles of chemiſtry, I endeavoured to find it in the relation which alkaline pruſſiates have with metallic ſolutions. It is well known that they decompoſe them all in conſequence of that double affinity by which the pruſſic acid abandons its firſt baſe to form with the metallic oxide an inſoluble pruſſiate, coloured according to the nature of the metal. Setting out from this principle, I diſſolved cryſtallized pruſſiate of potaſh in diſtilled water, and mixed this ſolution with a part of the ſuſpected wine. Having left this mixture expoſed to the air for twenty-four hours, and then finding no other changes but a few atoms of pruſſiate of iron, very diſtinguiſhable by its blue colour, I conſidered myſelf as authorized to announce that the wine in queſtion did not contain the leaſt particle of lead.

3d, To give to this firſt proof that degree of evidence of which it is ſuſceptible, and to place the principles of it beyond all doubt, I mixed another part of the ſuſpected wine with a ſingle drop of the acetite of lead; to this mixture two drops of the ſame ſolution of pruſſiate of potaſh (2d) were added, and I immediately obtained a precipitate of a dirty white colour, being the pruſſiate of lead, and proving in the fulleſt manner, that in the preceding experiment the ſame wine muſt have given the ſame precipitate if it had contained the ſmalleſt particle of lead.

4th, To theſe proofs and counter-proofs by the pruſſiate (2 and 3), that of the muriatic acid was added: the latter, as is well known, ſeparates lead from its ſolutions under the form of a muriate very little ſoluble; it did not diſturb the tranſparency of the ſuſpected wine, nor produce any change in it: this, then, ſtill tends to prove that the above ſuſpicion was ill founded.

5th, The proof by ſulphuret of potaſh, propoſed long ago as the ſure means of detecting lead in wine, had been employed by the perſon above mentioned. A number of cauſes, well known, render this proof doubtful; and it is well known that it is concluſive only when the preſence of the metal alluded to has been proved by complete deoxygenation, bringing back the oxide to the ſtate of metal. For want of this verification, this proof has very often been the ſource of errors, the more ſerious as the ſuſpicion to which they give riſe is odious. It was more than probable that the ſame cauſe had in the preſent caſe produced the ſame effect; but it was of importance to prove it, which was done as follows:

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The reagent in queſtion was made in the proportions and manner indicated by the perſon who had employed this teſt *: equal parts of ſulphur and potaſh (cauſtic) were diſſolved in a ſufficient quantity of diſtilled water; ſome drops of this ſolution, which the ſaid perſon called *ſulphuret*, and to which he ought to have given the name of *hydrogenated ſulphuret*, were mixed with the ſuſpected wine, and no other change was produced, but that which ought to take place in pure wine of the ſame kind, viz. a decompoſition of the ſulphuret, either by the malic acid or by the tartareous acid of the acidulous tartrite of potaſh. Had this wine held in ſolution a particle of lead, the latter muſt neceſſarily have immediately formed, not a ſalt, as the author of the note ſays, but a metallic ſulphuret, inſoluble, and eaſy to be diſtinguiſhed by its colour; being at firſt of a reddiſh brown, and paſſing ſoon to dark brown. But as the wine did not experience from this reagent any other change than that ariſing from the ſaid decompoſition, giving firſt a white cloud, then ſome traces, ſcarcely ſenſible, of a depoſit of the ſame colour, which is nothing elſe than the ſulphur precipitated, it is ſtill proved the wine did not contain a particle of lead.

6th, Another part of the ſame kind of wine, but known to contain lead, was employed to confirm the proof (5) by a counter-teſt: a drop of the ſolution of acetite of lead was put into it, and hydrogenated ſulphuret being then added, I immediately obtained the inſoluble ſulphuret of lead of the colour which I have mentioned.

7th, Having at hand all the apparatus neceſſary for theſe reſearches, I applied them to red wine ſold in a tavern. One part of this wine being mixed with a few drops of the ſolution of acetite of lead, and then with hydrogenated ſulphuret, the ſulphuret of lead was immediately announced by a change of colour. The purple paſſed to blackiſh, and ſoon after the metal was detected by an abundant depoſit of the ſame colour. One part of the ſame red wine being mixed with hydrogenated ſulphuret, without adding acetite of lead, the difference of the phænomena was ſo ſtriking, that it alone is ſufficient to give confidence to perſons whoſe regard for their health may induce them to make trials of this nature: the change of colour is no leſs ſpeedy in pure wine than in that which contains lead, but this change is altogether oppoſite to that which I have here noted. Red wine containing lead grows darker by hydrogenated ſulphuret; pure red wine, on the other hand, when the reagent is mixed with it, exchanges its

* This indication, under the title of a note on the experiment, was tranſmitted to me with the wine.—O. R.

purple

purple colour for a bright roſe red, and of ſo beautiful a ſhade, that on ſeeing the liquid become turbid, the hope of obtaining a precipitate ſuſceptible of becoming uſeful to the arts does not enter into the domain of illuſions, till the filter and the want of a ſenſible depoſit obliges the artiſt to acknowledge his error.

LVII. *Memoirs of the Life of* JOHN ROBISON, *LL.D. Profeſſor of Natural Philoſophy in the Univerſity of Edinburgh, &c.*

THIS eminent mathematician and philoſopher is a native of the South of Scotland, the ſon of worthy parents, in the middle condition of life.

He had, as ſoon as he was at an age capable of literary inſtruction, the advantage of attending one of thoſe pariſh-ſchools, which are ſo much celebrated as the ſources of the general and extraordinary intelligence of the Scots, acquiring, with great eagerneſs and facility, that knowledge of Engliſh, Latin, Greek, writing, and arithmetic, which uſually forms at ſuch ſchools the complete courſe. He was conſidered as a genius that ought to be devoted to one of the learned profeſſions; and his parents reſolved to bring him up to be a clergyman.

He went to purſue his ſtudies at the univerſity of Glaſgow, in which ſome of the moſt eminent philoſophers of the age were then teaching with great reputation and ſucceſs. In every branch of ſtudy he made diſtinguiſhed proficiency, but MATHEMATICS ſoon became his favourite. Dr. ROBERT SIMPSON was his maſter in this ſcience; and it is well known how much that great man contributed to the reſtoration of antient mathematics, and to the general diffuſion of a taſte for mathematical knowledge, among his contemporaries. The ſciences which are employed upon pure truth and reaſoning, if, at a firſt trial, harder and leſs inviting than moſt other parts of ſtudy, yet, when their firſt difficulties are, by an ingenuous mind ſurmounted, rarely fail to delight and captivate, and abſorb the whole ſoul, more than any thing elſe that can become the ſubject of inveſtigation or continued thought. With Dr. ROBISON it was perfectly ſo. His firſt progreſs in mathematics was eaſy and rapid; and, as he advanced, his paſſion for inveſtigating mathematical truth became continually more ardent, his intuition keener and more vivid, his perſeverance in unravelling

ravelling the moſt complex and tedious intricacies of deduction, ſtill more ſteady.

Of ANTIENT MATHEMAMICS, in all its parts, he was ſoon a maſter; but, as it employs words for its ſigns in reaſoning, as it ventures on few daring abbreviations and ellipſes in its chains of demonſtration, as its forms are apt to cumber and cramp the march of a vigorous mind in tracing mathematical truth, as it is in many reſpects ill-adapted to thoſe calculations and inquiries which the due proſecution of the modern diſcoveries in aſtronomy and other parts of phyſics neceſſarily demands,—it was, therefore, natural that he ſhould earneſtly proceed to the ſtudy of a *Syſtem of Signs* for the uſe of mathematical reaſoning, and of methods of abbreviation founded on the peculiar convenience of thoſe ſigns, which were much fitter to give due ſcope to the intuitive force and activity of reaſoning powers like his. ALGEBRA engaged and pleaſed him ſtill more than the previous parts of mathematics. He was eſpecially delighted with that mode of it, for the honour of whoſe invention Newton and Leibnitz, with perhaps nearly equal claims, contended, and which, by ſubjecting the relations of infinite quantities and magnitudes to ſtrict mathematical eſtimate, ſeems abſolutely to exalt and enlarge the powers of man beyond the native deſtination of humanity. As he took a peculiar delight in the ſtudy of FLUXIONS, ſo he, of courſe, advanced in the knowledge of them far beyond any of his fellow-ſtudents. He purſued them eagerly in all their applications to the calculations of aſtronomy, of mechanics, and even of moral probabilities. He contrived to employ them in the ſolution of a variety of problems, in regard to which more prolix methods of demonſtration had been hitherto uſed.

Nor was his proficiency confined to mathematics alone, even at the time of his being the moſt ardently devoted to this ſtudy. He excelled in the knowledge of thoſe authors who belong to the province of polite literature, in taſte to diſcern their beauties, and in ſkill to enrich his mind with the moral wiſdom with which they are pregnant. He entered deep into the ſtudy of moral philoſophy. He became no mean proficient in that philoſophy of public œconomy and legiſlation which at that time was with ſingular fondneſs cultivated at Glaſgow. To the profeſſional ſtudy of theology, indeed, he became firſt indifferent, and then averſe; not, however, out of any ſcepticiſm concerning the truths of chriſtianity, but from that ſtrong paſſion which engaged him to devote his whole life, if it were poſſible, to the advancement of mathematical ſcience.

The ſtudy of mathematics has generally the effect to form to penſive and compoſed habits of thought, the ſtudent who attaches himſelf to it earneſtly. It had, at an early hour, this influence on Dr. ROBISON. In ſocial converſe he was the delight of his fellow-ſtudents, and was capable of as much vivacity and cheerfulneſs even as thoſe among them who might be the moſt innocent of profound thought. But, he delighted to ſhut himſelf up and muſe alone in his chamber, to ſteal out in ſolitary walks along the banks of the Clyde, to indulge in that ſtudious melancholy which is ſo much akin to true genius. It was not without a ſort of friendly violence that he could be carried from this employment of his hours away into ſociety. But his converſation, when he could be brought among them, was too engaging, not to invite his companions often thus to break in upon, what they thought, the extreme ſeverity and reclufeneſs of his ſtudies.

He was contemporary as a ſtudent in the univerſity of Glaſgow with a number of gentlemen, profeſſors and ſtudents, who, like himſelf, will ever be diſtinguiſhed among the firſt ornaments of the age to which they belong. He obtained the friendſhip of Mr. WINDHAM, lately *Secretary at War*, who was then acquiring, under MILLAR and SMITH, the principles of political, œconomical, and legiſlative philoſophy. RICHARDSON, ſince eminent as a poet, a critic, a philoſopher, and a profeſſor, about that time finiſhed his ſtudies at Glaſgow, and went to Ruſſia in the family of the late Lord Cathcart, the Britiſh Ambaſſador to that Court. Dr. JOHN GILLIES, the learned interpreter of Ariſtotle, was then entering ſucceſsfully upon the ſtudies in which he has become ſince ſo eminent. Dr. ROBISON lived, for a time, in the houſe of Principal LEECHMAN, one of the moſt pious, learned, and liberal-minded divines, that adorned any religious eſtabliſhment in the eighteenth century.

The civilization of RUSSIA, as far as it has advanced, has been the work chiefly of the *Germans* and the *Scots*. Her Imperial Majeſty, Catherine the Second, was then reviving the great naval deſigns of Peter the Firſt. She was, for that end, deſirous to eſtabliſh marine ſchools, in which young ſea-officers might be inſtructed in thoſe parts of mathematics without which a ſhip's reckoning cannot be kept, obſervations cannot be made at ſea, nor can the duties of a naval engineer be performed. By the intervention, we believe, of Lord Cathcart, an invitation from the Ruſſian Government was ſent, to draw a number of young mathematicians from the univerſities of Scotland, to teach in thoſe

marine ſchools. Dr. ROBISON, glad to eſcape from theology to the profeſſional purſuit of mathematics, was one of the foremoſt to embrace the invitation. He went from Glaſgow to St. Peterſburgh; and entered ſoon after upon his functions, as the mathematical teacher in a marine ſchool, we believe, at Cronſtadt.

In teaching mathematics he was employed to his wiſhes; but he ſoon felt it exceedingly irkſome to paſs his days in explaining the firſt ſimple elements of that ſcience, to youths rude, turbulent, careleſs, and illiterate, and in whoſe native language he had, for a time, ſome difficulty to make himſelf readily underſtood. The emoluments of his appointment were comparatively ſmall; and the manner of living differed ſo much from that to which he had been accuſtomed in Scotland, as to be conſiderably diſagreeable to him. He found that, for his favourite ſcience, he had made a great ſacrifice, and had actually gone into a painful exile.

Yet he was not without experiencing ſome flattering conſolations: his addreſs and perſonal appearance, uncommonly graceful and ſtately, beſpeaking rather a military man of high rank, than an obſcure mathematician, recommended him to the polite notice of the beſt company wherever he had occaſion to appear. He had become in Scotland a freemaſon; and his connexion with that fraternity introduced him, with advantage, to many reſpectable perſons who were enthuſiaſts for freemaſonry in Ruſſia. There were at St. Peterſburgh ſome Scottiſh merchants, men of pleaſing manners and liberal education, who knew how to eſtimate merit and talents like Dr. ROBISON's, at their juſt value; and were, therefore, ever ready to diſtinguiſh him by every agreeable civility in their power. Of theſe, he delighted chiefly in the ſociety of Mr. PORTER, a gentleman who, after paſſing like himſelf with the higheſt ſucceſs through a complete courſe of academical ſtudy, had been led by the circumſtances of his life to engage in trade at St. Peterſburgh; and, with manners the moſt amiable and the beſt of hearts, unites ſuch a knowledge of books with ſo much of deep inſight into the human character in all its diverſities, and ſuch a ſkill in the modes of buſineſs, as one ſhall very rarely find together in one man in any country, or in any condition of life.

But it was, above all, in the purſuit of mathematical and philoſophical diſcovery that Dr. ROBISON found his beſt reſource for amuſement in Ruſſia. An occaſion fortunately aroſe to enable him to turn that diſcovery to advantage. A PLAN was required by the Empreſs, according to which the Imperial

Imperial palace might be the moſt *conveniently* and *certainly* ſupplied with water. Dr. ROBISON, putting his mathematical ſkill to uſe, as a civil engineer, offered a plan that was preferred to a variety of others which the ſame occaſion produced. A more honourable appointment, preſent emoluments conſiderably augmented, and the grant of a moderate penſion for life, were his rewards for a ſervice ſo acceptable.

All this, however, could not make him prefer Ruſſia to the remembrance of Scotland; and his deſire of return to his native country was at length fulfilled. He was, about 25 years ſince, upon the death or retirement of Mr. RUSSEL, invited, in conſequence of the high reputation to which he had attained, to fill the chair of natural philoſophy in the univerſity of Edinburgh.

High expectations had been raiſed of extraordinary ability to be diſplayed in his lectures in that ſituation. It was amply gratified. The writer of this ſketch heard his lectures in the ſeſſion of 1780-81, and in ſome ſeſſions ſubſequent; and it is but juſtice to own, that, in accuracy of definition, in clearneſs, brevity, and elegance of demonſtration, in neatneſs and preciſion in experiments, in the comprehenſiveneſs of his courſe, extending to every branch of phyſics and of mixed mathematics, and even in fullneſs of detail in each particular diviſion, a more perfect ſyſtem of academical lectures is not to be eaſily imagined. Yet, as men of great original genius in ſcience cannot eaſily endure to dwell for ever in the detail of its ſimpleſt and moſt familiar elements; as they find it often difficult to confine themſelves to the uſe of thoſe media in reaſoning and demonſtration which are alone intelligible to ignorance; as their natural march of thought is not ſeldom too bold and rapid to be cloſely followed by genius and knowledge much leſs than their own; not a few, even of the moſt ingenious of Dr. ROBISON's hearers, were found, at times, to complain, that they could not always, with clear underſtanding, purſue him through thoſe ſeries of demonſtration of the truths in mixed mathematics, with which his lectures were filled. He heard their complaints with kindneſs, and endeavoured to accommodate his inſtructions ſtill more and more to their apprehenſion. But, till Mr. PLAYFAIR, the preſent Profeſſor of mathematics in that univerſity, had perſuaded the young men intending to ſtudy natural philoſophy, to pay much more previous attention than had been uſual to pure mathematics, the ſubject of the complaint was never entirely removed.

When the ROYAL SOCIETY of EDINBURGH was inſtituted

ſtituted; Dr. ROBISON was perſuaded by the members to undertake the duties of Secretary to its philoſophical claſs. He has diſcharged them in a manner highly honourable to himſelf, and uſeful to the views of the Society. He has enriched ſome of the printed volumes of its TRANSACTIONS with papers which ſignally diſplay his profound knowledge, and the wide, vigorous graſp of his genius as a philoſopher and mathematician.

In his zeal to promote mathematical ſcience, particularly in its application to the uſeful arts, he condeſcended to contribute to the laſt edition of the ENCYCLOPÆDIA BRITANNICA the greater part of its articles in mixed and pure mathematics. They have been unanimouſly diſtinguiſhed, throughout Europe, as infinitely the beſt of the original articles in that compilation. The SUPPLEMENT, alſo, which has been ſince added to it, owes ſome of its beſt materials to his hand.

Having been led to think that the combination of the FREEMASONS might, in this revolutionary age, be abuſed to dangerous purpoſes, he broke off, ſome years ſince, his connexion with that fraternity; and wrote and publiſhed an eloquent book to explain the grounds of his fears, and the reaſons of his ſeceſſion. We preſume not to judge between him and his opponents in this matter: but it will be fortunate if the Freemaſons ſhall, with one accord, conſpire to prove that he has misrepreſented them, by the loyalty and peaceable patriotic rectitude of their conduct, in every part of the world.

Soon after his return from Ruſſia he entered into the married ſtate, and is now the father of a promiſing family. Some of his children are now grown up, and ſettled in life.

For a conſiderable number of years the ſtate of his health has been uncertain and languid. But nothing could induce him to any continued remiſſion from thoſe ſtudies in which he delights and excels.

LVIII. *On Bleaching. By a Correſpondent.*

To the Editor of the Philoſophical Magazine.

SIR,

IN your laſt number for July, p. 102, in O'Reilly's eſſay on bleaching, it is directed, if a *bright whiteneſs* be required,

that, after each proceſs of vapouring, the ſtuffs be rinſed "always in water a little *ſoapy*, made with 2*oz.* of that ſubſtance for each *lb.* of wool." It may be neceſſary to caution thoſe who have never made any experiments in bleaching with ſulphureous acid vapour, that ſoap even of the very beſt quality will always give the ſtuffs a *yellow* tint, and that too though it be uſed in only 1-4th the quantity here preſcribed. Indeed, from a number of experiments made about three years ago, (which I now quote from memory) I am convinced, that to attain a bright white, by the uſe of ſoap after the ſulphureous acid, will be a very difficult, if not impracticable, attempt. Of ſilk I may venture to ſpeak more poſitively; that the brighteſt white poſſible to be made, *cannot* be produced where *ſoap* has been uſed after the ſulphuring proceſs. It is in vain, however, to have recourſe to the expenſive and dubious effort of ſoap, when weak alkaline leys are equally ſafe for the ſtuffs, much cheaper, and much more certain of producing a bright white. In ſome peculiar kinds of ſilk, where the ſulphureous acid vapour, (applied nearly in the ſame manner as directed in O'Reilly's valuable eſſay) the oxy-muriatic acid, with ſoaps and alkaline leys, have all failed to produce a bright white, it has been effected by a mixture of ſulphuric and muriatic acids, diluted ſo as not to impair the texture of the cloth. The proportions of the latter I cannot at preſent ſpecify.

J. A. B.

Tokenhouſe-Yard, Aug. 25, 1801.

LIX. *Facts reſpecting the Tranſition of a Species of Fly, from the Chryſalid to the Volatile State. By Mr.* JOHN SNART, *Optician* *.

SIR,

Tooley-Street, London, (No. 209,) Aug. 17.

THE following particulars, the reſult of ſeveral hours obſervation, which I made upon the development of a ſpecies of fly from the chryſalis or piſcatory to its volatile ſtate, may prove acceptable to your readers; and the more ſo as it ſeldom happens that people chance to be in thoſe circumſtances which can make them witneſs the facts I mean briefly to deſcribe:

June 7th, being Sunday, Fahrenheit's thermometer at 75°, I obſerved in a water-but, which had not been cleanſed for near three weeks, a ſmall annulated and variegated worm

* Communicated by the Author.

riſing

riſing to the top of the water, as if the latent fire, by kindling, had diminiſhed the ſpecific gravity of the body, (which in length was about four lines, and in diameter one line); ſoon after I ſaw another, and another yet appeared, until there might be about twenty of them, all formed alike; *i. e.* large toward the head, with a tuft of fine white hair iſſuing from each ſide of the apparent mouth. The ſight being novel I took my ſtation, and a few good magnifiers to watch the event; for, ſeeing ſo vigorous an exertion in each one, and in ſo uncommon and frantic a way, as the delicacy of their muſcles did not ſeem equal to ſupport long, I anticipated a cataſtrophe of ſome kind or other. I had the curioſity to touch ſeveral to try what effect it would produce, and found it a ſtimulus adding new energy to their already amazing agility. They continued theſe violent contortions and dilatations until they appeared quite ſpent; in the laſt effort, however, and after a ſudden contraction, and as ſudden an expanſion, with a kind of wriggle (they have no fins), they would come quite to the ſurface of the water, and, an inteſtine motion taking place, a cleft began to appear upon the back part of the head of this little amphibious creature, out of which, to my great aſtoniſhment, I ſaw emerging, as if propelled by an inward ſcrew, a creature quite of another element, form, and quality; in a word, a gregarious fly, a gnat; from which I judged, (not underſtanding the metempſychoſis) that the ova muſt have been depoſited in the mud, and that in this bed, under the agency of the parent fly, or perhaps nature, the nidification was performed while the incubation was perfected by the water and ſun; the laſt of which had now beſtowed its quickening influence, and revived them from their torpid ſtate. The confines of their priſon, wherein both wings and legs were contracted and bound down to their bodies in a very ſmall compaſs, (as I have ſtated above) beginning to rend aſunder, at firſt appeared their beautiful antennæ (if males), or more beautiful plumage (if females); next the two palpi or feelers, and as many bold and reticulated eyes, whoſe prominence is ſuch as to give the poſſeſſor the privilege of commanding near a whole ſphere at one view; with this ocular advantage, together with wings and ſting, compenſation is pretty well made for the weakneſs of their bodies, and the brevity of life, at leaſt, ſo as to ſet them upon a level with more promiſing creatures; the head being now wholly advanced, the body next appears with wings and legs, which heretofore were bound up in a kind of ſwathing, but now rejoice to unfold themſelves and act according to their different functions, the legs as ſupporters, the wings as ſails, which

immediately, nautilus like, are ſpread to wanton in the breeze. And now, wholly emancipated, they ſtretch their ſilken pinions, and launch forth to run a new career, and——

> Exulting ſpread the wing to fly aquatic care,
> Then ſpurn the narrow cell, and fan the buxom air;

while the lifeleſs cuticle, in form a ſhark, in texture like the pith of a quill, is now deſerted, and left to rot on the ſurface of the water, while its former inhabitant and priſoner commixes with beings of another element, and forgets his baſe original.

> So men might take example by theſe flies,
> Leave earthly cares and emulate the ſkies.

Some few, however, fell victims to that element which had firſt cheriſhed them; for if by any accident they happened to fall into the water, and their wings got wet, they were incapable of diſengaging themſelves (yet thoſe that I ſaw ſo circumſtanced I ſet at liberty): others, though comparatively few, came to the birth, and were incapable, through want of ſtrength, to bring forth, in which caſe I undertook, by the aſſiſtance of two needles, the part of accoucheur and brought them forth, though much maimed.

I remain, Sir,

Your obedient Servant,

Mr. Tilloch. JOHN SNART.

LX. *Brief Account of the Iſlands of Banda. By a Gentleman who ſurveyed them ſince they came into the Poſſeſſion of Great Britain*.*

THE iſlands of Banda, ſituated 130 miles to the ſouth ſouth-eaſt of Amboyna, are ten in number, viz. Banda Neira, Gonong Api, Banda Lantoir, Pulo Ay, Pulo Rondo, Roſyngen, Pulo Piſang, Craka, Capella, and Sonangy; of theſe, Banda Neira is the ſeat of the ſupreme government of the whole. In Gonong Api there is a volcano which conſtantly emits ſmoke, ſometimes accompanied with a crackling noiſe: the ſurface of the iſland is covered with a quantity of ſulphur and chalk. There is no vegetation whatever on upwards of one-third of the eminence on which the volcano is ſituated: there is a ſteep deſcent on the outſide of it toward the ſea, but, towards the harbour, the declivity ſlopes gradually to the water, on the ſide of which are ſome plantations and a few

* From the *Aſiatic Annual Regiſter for* 1800.

ſtraggling

ſtraggling houſes. In the ſpace between Banda Lantoir and theſe two iſlands there is a very good harbour, formed with entrances both from the eaſt and weſt, which enable veſſels to enter it in either of the monſoons: theſe channels are well defended with ſeveral batteries, particularly the weſtern one, which is, moreover, very narrow. Between Gonong Api and Banda Neira there is a third channel into this harbour from the north, but it is navigable only to ſmall veſſels. Pulo Ay is about nine miles weſt of Gonong Api, and Pulo Rondo about four miles further, in ſomewhat a more northerly direction. On the latter iſland the Engliſh had once a factory; but at the time they were expelled from Amboyna they were alſo driven from thence, and the Dutch, not chooſing to inhabit the iſland, it ſoon grew into a wilderneſs. Pulo Piſang is ſituated north-eaſt of Banda Neira about two miles, and yields ſome fine fruits, as well as mace and cocoa nuts, but not any nutmegs. Roſyngen is about ſeven miles to the ſouth-eaſt of Banda Lantoir; it produces mace and yams, and feeds ſome cattle. The convicts of Amboyna uſed to be kept on this iſland, and were compelled to cultivate the land for the uſe of the ſupreme government. The other three iſlands are nothing more than ſmall barren rocks.

The nutmeg-tree is cultivated only in the four firſt mentioned of theſe iſlands; but the Dutch thought it adviſable to prohibit the cultivation of it in the other iſlands, on account of their diſtance from the ſeat of government, and of their thereby affording greater opportunities of ſmuggling. The iſland of Banda Lantoir appears very high from the ſea; its hills are ſteep, and from the top of them there is a ſort of table land, which extends nearly from one end of the iſland to the other. The Banda iſlands are all high; but Gonong Api, which riſes 1940 feet from the ſea, is the higheſt of them.

The ſoil of all theſe iſlands, except that of Gonong Api, which is for the moſt part lava, is an exceedingly rich black mould, every where covered with trees, chiefly nutmegs. The almond-tree grows in great plenty, and is very uſeful, as well for the ſhelter it affords the nutmeg-trees, as for the fruit it yields. There are alſo ſandal-wood trees, and a variety of others which grow wild. Near the ſea ſide, round the different iſlands, trees of all kinds are permitted to grow, as they are conſidered uſeful in keeping off the ſpray of the ſea in ſtormy weather from the nutmeg-trees, which is very prejudicial to them.

The principal fortification in the Banda iſlands is Fort Naſſau, which is ſituated on the ſouth ſide of Banda Neira; it is a ſmall ſquare fort, with a wet ditch, defended by a horn-

work towards the ſea. In this fort the troops are quartered, and the public granaries are kept; but the ſtorehouſes for the nutmeg and mace are on the outſide of the fortreſs, and ſituated near the government houſe. Above Fort Naſſau, on an eminence, ſtands the caſtle of Belgica *; an old pentagon with round towers at the angles, and a ſurrounding wall with ſmall baſtions; but it has no ditch: it is ſaid to have been built by the Portugueſe. The next fortreſs of any conſequence is ſituated on the iſland of Banda Lantoir, and is called Fort Holandia. It commands the weſtern entrance into the harbour of Lantoir; but the works are very flimſy, and quite defenceleſs towards the land.

At a firſt view, the ſituation of this fortreſs appears infinitely preferable to that of any in theſe iſlands for the reſidence of the ſupreme government, not only on account of its being the ſtrongeſt, and the moſt commanding ſituation, but from this iſland being the largeſt, as well as the richeſt, in reſpect to the produce of ſpices. Its unhealthfulneſs, however, proves a ſufficient objection; and numbers of houſes, now mouldering into decay, ſhow that the experiment has been tried, and found not to anſwer: moreover the water is ſaid to be bad, and the vapour, which ſometimes deſcends from the volcanic mountain of Gonong Api, is repreſented as being particularly noxious. Theſe circumſtances ſeem to be confirmed by the experience of the Wirtemberg company, who formerly garriſoned this fort; and out of a hundred men eight died, and forty fell ſick, in the courſe of two months.

Beſides the above-mentioned forts, there are a number of redoubts and military poſts all round theſe iſlands, for the purpoſe of preventing ſmuggling, and of protecting the plantations and the villages ſituated on the ſhores againſt the predatory invaſions of the Papoo pirates, who infeſt theſe ſeas in large prows, and frequently land and carry off the inhabitants, and whatever elſe they can take by ſurprize, though they are ſeldom hardy enough to attack where reſiſtance may be expected. The two redoubts of Kyk and the Kap, both ſituated on the ſouth ſide of Gonong Api, were originally intended to defend the weſt channel of Lantoir harbour; but, owing to the irruption of the volcano in 1778, at the ſame time that a dreadful hurricane laid waſte the whole of the iſlands, the lava flowed down in ſuch quantities as to form a conſiderable promontory between theſe batteries and the channel they were intended to defend, ſo that they are now, in a great degree, uſeleſs. Some material improvements,

* The *g* in this word is pronounced hard as in give, and the ſyllable long.

however,

however, which have been recently made to the batteries of Batavia and Sebergorberg, have put the weſtern channel into a ſtate of ſecurity; and a new battery, which has been erected on the north-eaſt part of Banda Neira, renders it a difficult matter to force an entrance into the harbour by the eaſtern channel.

The frame of this government is different from that of Amboyna; the whole ſociety conſiſts of the company's ſervants, ſome burghers, and ſlaves. The ſole object of their attention being the care and cultivation of the nutmeg-trees, the affairs of government cannot be ſuppoſed to be very complicated: nevertheleſs it is at preſent a diſtinct eſtabliſhment, conſiſting of a governor, a council of three, and a ſecretary, together with a regular court of juſtice as at Amboyna; but the governor of Banda not being ſubject to the check, much leſs the control, of any ſuperior authority, his will may be juſtly conſidered the only law of the ſettlement.

The Dutch company were the abſolute proprietors of the ſoil, as well as of the ſlaves who cultivate it. The rearing of the nutmeg-tree being the only object in view, thoſe iſlands that produce it are divided into a number of plantations, or parks, as they are termed, which are ſuperintended by native burghers, deſcendants of the Dutch, who originally ſettled in theſe iſlands. A certain number of ſlaves belonging to the company is allotted to each park, whom the park-keepers employ in the cultivation of the nutmeg-trees. They are ordered to ſend daily two-thirds of their ſlaves to the parks to clear the trees and to gather the ripe fruit, as well as to pick up all that may have fallen from the trees in the night: for this purpoſe each ſlave is furniſhed with a ſmall baſket and a hoe.

When the nutmegs are brought in, the mace is ſtripped off, and kept in baſkets to dry in the ſun; and the nutmegs with ſhells on, are put into a drying-houſe allotted for the purpoſe, where they remain, on hurdles expoſed to the influence of a ſlow fire, and to ſmoke, for about three months; when they are dry, their ſhells are broken, and the fruit put immediately into chunam or lime, which is neceſſary to preſerve them from worms and other inſects. It requires much experience, as well as a conſiderable degree of judgment, to aſcertain the preciſe time that they ſhould be ſuffered to remain in the lime; for if they be taken out too ſoon they are worm-eaten, and if left too long in it, they are burnt up, and rendered uſeleſs. After the nutmegs are taken out of the lime, they are cleaned and packed up in rattan bales of 200lb. ready for being ſhipped. The mace is delivered into ſtorehouſes every month, and the nutmegs every three

months: they are both paid for on delivery, the mace at $7\frac{1}{2}$ ſtivers per pound, and the nutmeg at $2\frac{1}{2}$. From this price, however, a deduction is made of 17 per cent. from the weight of the ſpices; 10 per cent. in favour of the company as an acknowledgment of their right to the ſoil, and 7 per cent. in favour of the ſervants of the company. The 7 per cent. is an old cuſtom; but the additional 10 per cent. has only been levied a few years previous to the arrival of the Engliſh.

The quantity of nutmegs and mace produced for ſeveral years paſt, has been inconſiderable, owing to an unaccountable inattention in the collection of them. But ſince the arrival of Mr. Boeckholtz, the late Dutch governor, the produce was ſo much increaſed, that the half-yearly collection which was found in ſtore when taken poſſeſſion of by the Engliſh in 1796, amounted to 81,618 lb. of nutmegs, and 23,385 lb. of mace. This was the firſt half year's crop ſince Mr. Boeckholtz's government had commenced; the crop of the half year following equalled it in quantity; and in future years, under proper management, the quantity produced may with confidence be ſuppoſed to average 600,000 pounds of cloves, and 200,000 pounds of nutmegs—an eſtimate founded upon the moſt moderate computations of the moſt experienced and beſt informed perſons in the Spice iſlands.

The nutmeg-tree grows to the ſize of a pear-tree; its leaves reſemble thoſe of the laurel; it begins to bear fruit at ten years growth, and the fruit improves in quality and increaſes in quantity until the tree has attained the age of a hundred years. It requires to be ſecurely ſheltered from the hurricanes to which theſe iſlands are ſometimes expoſed; for many of the nutmeg-trees are ſituated on the ſteepeſt ſides of the hills, where they cannot take deep root, and by conſequence are likely to be torn up by ſudden guſts of wind. It is aſſerted that the chief loſs which the nutmeg plantations ſuſtained by the hurricane in 1778, was in conſequence of a great many of the almond-trees, which had afforded them ſhelter, having been cut down.

The nutmeg, when ripe on the tree, has both a very curious and beautiful appearance: it is about the ſize of an apricot, and nearly of a ſimilar colour, with the ſame kind of hollow mark all round it; in ſhape it is ſomewhat like a pear: when perfectly ripe, the rind over the mark opens, and diſcovers the mace, of a deep red, growing over and covering in part the thin ſhell of the nutmeg, which is black.

There are perſons called foreſters who ſuperintend the parks and the drying of the nutmegs and mace. They are directed to make regular reports to the governor reſpecting the ſtate of the

the different parks, and of the quantity of ſpices which they yield. Beſides theſe perſons there are directors of the parks, who viſit them every month to ſee that the trees are properly attended to, and planted at regular diſtances from each other; and alſo to obſerve whether the foreſters are active and careful in the execution of their duty.

Almoſt the whole of theſe iſlands being appropriated to the cultivation of nutmegs, they neither feed cattle nor produce grain enough for the maintenance of the inhabitants. Like Amboyna, they have therefore been ſupplied annually from Batavia with rice and other articles of proviſion.

All the aforeſaid regulations concerning the cultivation of the nutmeg-trees, and the price paid for the produce of them, were eſtabliſhed by the late Dutch governor, who arrived about fifteen months before the Engliſh took poſſeſſion of the Banda iſlands. Previous to his arrival, moſt of the planters were in great diſtreſs, having been charged with very heavy debts incurred on account of loans in rice and money, made at different periods, to the former governors: and this circumſtance, together with the great loſs which they ſuſtained by the dreadful hurricane in 1788, entirely ruined their private fortunes as well as their plantations. In this diſtreſsful ſituation, the Dutch government, with a wicked avarice, aggravated their miſery by compelling them to deliver their nutmegs at the reduced price of three farthings per pound, and the mace at a ſtill lower rate. Under the preſſure of this accumulated diſtreſs, the ſpirit which had animated their fathers in the rude days of their ſavage independence ſeemed once again to revive, and they remonſtrated in bold and determined language: they claimed the lands as their own preſcriptive inheritance, and actually proceeded to portion them out to each other. And the Dutch, though unſuſceptible of any feelings of remorſe for their own oppreſſive folly, which had reduced the country to this deplorable condition, had yet prudence enough to avert, by conciliatory meaſures, the imminent danger which threatened them; and when they found that the fury of the people was not to be appeaſed but by ample conceſſions, they gladly conſented to grant them. But the general idleneſs, and conſequent neglect of the nutmeg plantations, to which this inſurrection had given birth, reduced the annual quantity of ſpices from 600,000 lbs. to 50,0 0 lbs. weight. It was thought adviſeable, therefore, by the ſupreme government of Batavia, to adopt the ſcheme of reform propoſed by Mr. Boeckholtz, and to appoint him governor of the Banda iſlands. One of the firſt acts of his government was entirely to cancel the old arrear of debt, which was con-

ſidered as due from ſeveral of the planters to the company, and which moſt of them were little able to pay: he alſo made ſome judicious regulations with reſpect to the government of the ſlaves. The price of the ſpices was likewiſe raiſed at this time, from the old low rate to that at which it is now fixed.

The alterations were ſuppoſed to hold out great encouragement to the planters to give more attention to the culture of the nutmeg-trees, and thereby to increaſe the quantity of the annual produce. But, however ſpecious this ſuppoſition may ſeem, it is utterly unfounded in truth; for it will appear evident, from a cloſe examination of the ſubject, that although the ſyſtem of regulations eſtabliſhed by Boeckholtz be coloured with juſtice, it in fact depends on, and is intimately blended with, the moſt deſpotic principles, as the following circumſtances will ſufficiently explain. The debt which the Dutch government take the merit of having cancelled as an act of indulgence, deſerves not to be conſidered in that light; for the principal part of it was incurred on account of rice and other articles of proviſion given to the planters for their own uſe and for that of their ſlaves, and without which they would have periſhed and the ſettlement have been annihilated. And for this debt the planters certainly never expected to be made accountable, having, at the time they received it, conſidered it as a donation upon which their exiſtence depended. As to their other debts on account of loans of money, &c. though there were ſome individuals who, from idleneſs and inattention, were in low circumſtances, and unable to diſcharge them without mortgaging their little property, yet the greater part of the planters would have much rather continued in poſſeſſion of their parks, and paid the juſt demands upon them, than, under colour of remiſſion of theſe debts, be deprived of that which, from long undiſputed poſſeſſion, they conſidered as their actual right. Beſides, it appears that ſome of the planters had purchaſed their land from the company; and for the company, therefore, to repoſſeſs themſelves of thoſe lands by compulſion, was an act compounded of wanton inſult, treachery, and tyranny, which, as it juſtified the moſt exemplary vengeance, ſo it demands the ſevereſt reprobation.

In the four iſlands which produce nutmegs, there are fifty-ſeven plantations, and 1708 ſlaves; but there is no regularity either in the diviſion of the plantations or in the diſtribution of the ſlaves: and it would be one of the moſt eſſential ſteps towards the improvement of theſe iſlands to make an accurate ſurvey of them, to have the plantations better proportioned, and their boundaries more clearly defined. From the beſt

information,

information, it alſo appears requiſite to procure about 800 additional ſlaves, in order to bring the plantations into the higheſt ſtate of cultivation.

The want of inhabitants in theſe iſlands ſeems to impoſe the unfortunate neceſſity of keeping up the above-mentioned number of public ſlaves; though, when the expenſe attending their maintenance is compared with the little work they perform, they muſt be conſidered as the moſt expenſive people that could be employed. When works of any magnitude are carrying on, government are obliged to hire, at a very dear rate, the few free artizans who are willing to work, as well as the private ſlaves of individuals, whoſe labour their maſters turn to great advantage.

Excluſive of the proviſions ſent annually from Batavia to the Banda iſlands, there is alſo ſent a large ſupply of piece goods, cutlery, iron, and other articles of merchandize, which are ſold by auction either quarterly or at ſuch periods as the governor knows the inhabitants are beſt able to pay for them: upon all theſe articles there is a profit of fifty per cent. The burghers, and Chineſe merchants ſettled here, not only buy up all the goods which are ſold on the company's account, but alſo thoſe which are imported by individuals. For, beſides their own conſumption, the Chineſe merchants export the aforeſaid articles to the iſlands of Aron, New Guinea, Ceram, and the ſouth-weſt iſlands, between all of which and the Banda iſlands there is a conſtant traffic carried on. In return, they get from Ceram, ſagoe in bread and flour, and ſometimes ſalted deer; and from Aron they get pearls, birds neſts, and tortoiſe ſhells. From theſe iſlands they are alſo ſupplied with ſlaves.

The iſlands which lie ſouth-eaſt of Banda are very low, and ſurrounded with dangerous rocks and ſhoals. The natives of them as well as thoſe of New Guinea are extremely treacherous in their diſpoſitions and ſavage in their manners, notwithſtanding which the Dutch have a continual intercourſe with them.

The ſouth-weſt iſlands, as they are called, are ſeven in number, the chief of which is Kiſſier, in which the reſident or governor of the whole reſides. His garriſon conſiſts of fifty men, a few of whom are attached to the adjoining iſlands. The only advantage drawn from theſe iſlands is ſome ſandal wood and ſalted deer, which they produce, and a few ſlaves which they furniſh. The inhabitants of them are repreſented by the Dutch as being exceſſively ferocious. They appear to be a mixed breed, between the Coffereês of Africa and the Popoos, or natives of New Guinea: their hair is neither ſo

ſhort

ſhort or woolly as the one, nor ſo long and buſhy as the other; but in their features they bear a reſemblance to both.

In the laſt account of the Banda and ſouth-weſt iſlands, all of which are under the ſame government, the numbers of all deſcriptions of people were as follow*: The iſlands of Banda contain 5763 inhabitants, of which 119 are Europeans; and the ſouth-weſt iſlands contain 38,266, of whom 2322 were natives, who have been converted to the Chriſtian faith. From this ſtatement it appears that the population of the ſouth-weſt iſlands is very conſiderable, though the Dutch derived little benefit from them. Although ſo great a number of the inhabitants of theſe iſlands have embraced Chriſtianity, yet it ſeems to have had very little effect in promoting civilization among them; and, unleſs the Dutch kept poſſeſſion of thoſe iſlands, in order to prevent other European powers from eſtabliſhing themſelves in any ſituation that might open an avenue of communication between them and the Spice iſlands, the diſperſing their troops and extending their poſſeſſions to ſuch inconvenient, unprofitable, and hazardous diſtances, cannot well be accounted for.

However, as it is no leſs oppoſite to the policy than unſuitable to the diſpoſition of the Engliſh to extend their conqueſts from ſuch a motive, or form eſtabliſhments on ſuch principles, it is unneceſſary to take theſe iſlands under our conſideration in the following ſuggeſtions, which we throw out for the better management of the ſpice trade in Banda.

The circumſtance of Banda having been hitherto a diſtinct government, has at different times produced very inconvenient effects; and the great diſtance of Banda from the ſupreme government of Batavia has rendered it difficult to detect thoſe delinquencies which are ſaid to have exiſted for ſeveral years paſt in the adminiſtration of that iſland. Hence the governors being left without check or control, and their council poſſeſſing merely a nominal power, they attended to nothing but their own private advantage, and made no other uſe of the authority with which they were inveſted, but to defraud the company from whom they derived it: they not only ſent ſpices to the neighbouring iſlands on their own account, but even ſupplied the natives of them with fire-arms and military ſtores at the very time when theſe people were at war with the government of Amboyna. If, therefore, we conſider the value of the Banda iſlands, together with the evils which have ariſen from the manner in which they have

* The Aron iſlands, though alſo dependent on the government of Banda, are not included in this account of the population.

been

been governed, it appears essential to put them under the authority of the governor of Amboyna. He will thereby be enabled, from the contiguity of his place of residence, to make himself acquainted with all the occurrences in the subordinate settlement, regulate its intercourse with the adjacent countries, furnish it with every necessary supply, receive regular returns of the state and produce of its plantations, and finally, punish every infringement of the established regulations. By these means the affairs of the Spice islands might be conducted with an union and consistency which would at once extend their commerce and consolidate their strength.

With regard to the dispute between the Dutch company and the native burghers, relative to the right claimed by the latter of a property in the soil, though it behoves the justice of our government to investigate that claim, it were little instructive to our readers to enter into a consideration of it; for it cannot be of much consequence to have it ascertained who is the nominal proprietor of the soil, when the whole of its produce is monopolized by government. As the want of population, therefore, seems to be the greatest hindrance to the progress of improvement, the planters should be encouraged to increase the number of their slaves; and, in order to give them an interest in the produce of the soil, they should have the privilege of transferring their property.

The company are, at present, obliged to furnish the Banda islands with rice and other provisions at a rate so low as to subject them to a considerable loss; they are also liable to a vague and undefined charge on account of new buildings and repairs for storehouses, &c. all of which, in the general scale of expenditure, should be considered as deductions from the value of the spices. It would therefore be not only a material saving to the company, but far more suitable to the interests of the planters themselves, to increase the price of the spices, and make them chargeable with all the expenses attending those buildings and repairs; and also to furnish themselves with rice, which, however, the government must at any rate supply, but in this way would not lose by that obligation which necessity has imposed on them.

Upon investigating this subject with the most impartial and best informed persons at Banda, it appeared evident that this mode of arrangement would be the most agreeable to the people, and the most likely to produce beneficial effects to the state; and, with regard to the increase necessary to be made to the present price of the spices, an addition of $7\frac{1}{2}d.$ for the nutmegs, and $15d.$ for the mace, per pound, would sufficiently satisfy the planters.

As

As fmuggling is become very common in the Banda iſlands, and the company are thereby defrauded of great quantities of ſpices, a ſevere law ſhould be enacted againſt thoſe who purchaſe them, and the ſelling of them be made puniſhable by the forfeiture of all the property of the delinquents.

LXI. *Proceedings of Learned and other Societies.*

ACADEMY OF SCIENCES AT TURIN.

THIS Society has propoſed the following queſtions as the ſubject of two prizes, to be adjudged on the 23d of September.

1. To point out what are the different vices contracted by wine caſks; the modifications which wines experience by vitiated caſks; and the means of remedying both.

2d, To determine the phyſical and political cauſes of the decay of the woods and foreſts of every kind in the ſix ſubalpine departments; the means of preventing it; and thoſe of increaſing the cultivation of timber, eſpecially on the mountainous countries.

BOARD OF AGRICULTURE.

On the 9th of June the Board reſolved that a præmium of the gold medal be offered to each of the five perſons who ſhall, in the moſt ſatisfactory manner, prove, by experiment, the practicability of cottagers being enabled to keep one or two milch cows on the produce of land cultivated with the ſpade and hoe only, and who ſhall ſend to the Board, on or before the firſt of January 1803, the beſt accounts of ſuch experiments; detailing,

1. The expenſe of erecting the cottage, ſhed, and any other building thought neceſſary.
2. The expenſe of providing the ſtock and tools neceſſary.
3. The extent of land, and nature of the ſoil, occupied.
4. The expenſe of digging and fencing the land.
5. The rent, taxes, &c. paid for the ſame by the cottager.
6. The courſe of cropping that has been adopted.
7. The quantity and value of each of the different crops.
8. How the cottager and his family are maintained, and how they manage to cultivate the ground, and to harveſt the different crops.
9. How the cow is maintained during the year, and what profit is derived from it.

10. What

10. What profit is derived from pigs, poultry, and other articles.

11. How many days they were enabled to labour for other people. And

12. How, on the whole, the plan has been found to anſwer.

N. B. The Board reſerves to itſelf the power of withholding any præmium when the communication or communications are not deemed ſufficiently important to merit the reward.

The manuſcript, &c. ſent in claim of præmiums to remain the property of the Board.

All memoirs, &c. ſent in claim of præmiums to be without names, but with a mark or number, and accompanied by a ſealed letter (on which is to be written the ſame mark or number) containing the name and addreſs of the claimant, which ſealed letter will not be opened unleſs the præmium is adjudged to that mark or number.

XLII. *Intelligence and Miſcellaneous Articles. September* 1801.

THE NEW PLANET.

SIX aſtronomers of Lilienthal, near Bremen, have formed an aſſociation of twenty-four practical aſtronomers, charged with correſponding from different parts of Europe, and whoſe object is to ſearch for the planet ſuppoſed to exiſt between Mars and Jupiter, on account of the great diſtance of theſe two celeſtial bodies. M. Bode, the well known aſtronomer of Berlin, maintains that this planet to be diſcovered is nothing elſe than the comet ſeen by Piazzi. But the aſſociation are not ſatisfied with this idea. They have choſen as their preſident M. Schrœter of Lilienthal; they have divided the whole zodiac among the twenty-four aſſociate correſpondents, in order that each in his department may more eaſily follow the traces of the bodies, the poſition of which they are deſirous of aſcertaining. Almoſt all the aſtronomers ſelected for this employment have accepted the honourable taſk impoſed on them. Their ſerene highneſſes the duke and ducheſs of Gotha, ſeconding the zeal of M. Von Zach, author of the project, have preſented M. Wurmb, profeſſor, of Blaubeuren, with all the inſtruments neceſſary for making his obſervations. M. Sniaderly, profeſſor at Cracow, could not accept the part of the zodiac offered to him, becauſe the

univerſity

univerſity of Cracow is going to be ſuppreſſed, ſo that he muſt renounce the obſervatory of that city.

ASTRONOMY.

Paris. Sept. 13.

On the 2d of Vendemiare, year 4, I announced that I had determined the longitude of Rome by an eclipſe which I obſerved there in 1765. Since that time the duke of Lermonetta eſtabliſhed there an obſervatory, and ſent me an obſervation, which he made with profeſſor Scarpellini, of the eclipſe of the ear of corn of the Virgin, which took place on the 24th of May; it gave me 40 minutes 36 ſeconds for the difference of the meridians. I found the ſame thing by an eclipſe of the ſtar Sigma of the Lion, which the abbé Conti obſerved at Rome on the 24th of April. It was only four ſeconds more than by my former determination. Thus we at length know very exactly the ſituation of the cupola of St. Peter's, which I always call the moſt remarkable point of the world. LALANDE.

EARTHQUAKES.

An earthquake was felt at Edinburgh on Monday the 7th of September, at ſix in the morning. It extended through Fife, along the north bank of the Forth, from Kirkaldy by Aberdown, Dunfermline, Kincardine and Alloa; likewiſe northwards by Kinroſs, to ſome diſtance in a north-weſt direction to Callander, and various parts of Perthſhire. At Stirling and Glaſgow the ſhock was alſo very diſtinctly felt, at nearly the ſame time as in the other places mentioned. The appearances were nearly alike in all. At Edinburgh it continued two or three ſeconds; was preceded by a rumbling, ruſhing, hollow noiſe from the ground; and had a tremendous, undulating motion, ſomething reſembling the motion of the waves of the ſea. Beds, tables, chairs, &c. in ſome houſes were obſerved to ſhake, reſembling the rocking of a cradle. Some perſons who felt it had a very diſagreeable ſenſation, attended with a headach. The morning was gloomy, warm, and calm; the barometer high, and the thermometer about 50. The preceding day, Sunday, there was a good deal of rain. A parrot in a gentleman's houſe in the ſouth ſide of the town, ſcreeched ſeveral times during the ſhock, in the ſame manner as theſe birds do in the Weſt Indies, during an earthquake: and in one houſe the bells were ſet a ringing.

It would ſeem that this ſhock has been pretty general. At Dunfermline, its duration, it is ſuppoſed, was only two ſeconds. People who were in high ſtories, and conſequently had

had the beſt opportunities of obſervation, thought they felt two ſmall ſhocks, and in their ſituations, things that were hanging on the walls were evidently moved from their places, occaſioning ſome noiſe. Many people were awakened from their ſleep by the motion which they felt in their beds, which they generally deſcribe by the rocking of a cradle, or as if a perſon had lifted up one ſide of the bed from the floor, to which a tremulous motion ſucceeded for a ſhort ſpace. At Grangemouth, and over all that neighbourhood, two pretty ſevere ſhocks were felt, one at four, the other at ſix in the morning.

At Crieff it reſembled the ſudden fall of a houſe, attended with a rumbling noiſe, which continued about the ſpace of ſix ſeconds. It appeared to go from Weſt to Eaſt. One perſon ſtates that the roof over his head cracked, and appeared as if it would burſt. The rattling of the diſhes on the ſhelves, and the looſe partitions, helped to increaſe the fears of the people, who ran to the doors.

A letter from Stirlingſhire deſcribes it in the ſame manner. The writer ſays, "at ten minutes before ſix, I was ſurpriſed with a ſudden ſhaking of my bed, which continued for about half a minute. The motion ſeemed to come from beneath, but I can ſay nothing elſe concerning its direction. A ſervant who ſleeps in a room adjoining to my barn, was alarmed by the creaking which it occaſioned in the joiſts. There was not a breath of wind, and the ſky, though ſomewhat cloudy, was altogether calm. Soon after the morning became very bright and warm; nor was there any miſt on Benlomond, Benledy, or any of the neighbouring mountains."

On the morning when it was felt, the gable of a barn, a few miles to the weſtward of Edinburgh, where ſome ſhearers were ſleeping, fell in, whether from the inſtability of the building, or the concuſſion of the earthquake, is uncertain; but the unfortunate tenants were completely buried in the rubbiſh. When the accident was diſcovered, and theſe poor people dug out, two women were found dead, and another very much bruiſed, who was immediately brought to the Royal Infirmary. The others, eight or ten in number, were not much hurt.

It was obſerved at Leith, that the tides, for three days, had not ebbed ſo much as uſual at the then age of the moon; ſo much ſo, that the workmen at the New Dock had not been able to accompliſh the work they ordinarily do while the tide is out.

In the year 1755, when the earthquake deſtroyed a great part of Liſbon, there were ſmart ſhocks felt in different places

of Scotland; with violent agitations of Loch Neſs, Loch Tay, &c.

The foreign journals alſo notice an earthquake having taken place at Colmar on the morning of the 11th of September, which had ſpread a conſiderable degree of alarm. That morning, at a quarter paſt one, a great number of people were awakened by a hollow noiſe and certain agitation, which was felt in the houſes, and ſhook the furniture. Several ſhocks followed the firſt: at a quarter paſt two, there was one pretty ſtrong.

WATER-PROOF CLOTH.

To diſcover a proceſs for rendering cloth water-proof, without at the ſame time filling its pores in ſuch a manner as to prevent perſpiration, has long been a deſideratum. It gives us pleaſure to announce a diſcovery which promiſes ſo many advantages, in point of health and comfort, to all ranks in the community. By favour of the patentees, Meſſrs. Ackermann, Suardy, and Co. we are enabled to preſent our readers with a ſpecimen of the art, namely, a piece of blotting paper; one-half of which has been ſubjected to the water-proof proceſs. By ſprinkling a little water over it, the prepared part will eaſily be diſtinguiſhed.

GALVANISM.

At a late meeting of the committee for apparatus of the Aſkeſian Society, ſome experiments were made with a Galvanic trough, of the conſtruction invented by Cruickſhank. The one belonging to the ſociety conſiſts of ſixty pieces of ſilver, and the ſame number of pieces of zinc, each $2\frac{1}{4}$ inches ſquare. They are ſoldered together at the four edges, and are very exactly in contact. The trough is of mahogany, with grooves half an inch apart from each other. The pieces are ſecured in theſe groves by a cement, compoſed of hard varniſh and bee's wax. The cells between each pair were filled with a weak ſolution of muriat of ammonia a quarter of an ounce to two quarts of water, which is nearly the quantity the apparatus takes. The ſhock taken from this trough by two metallic conductors is felt plainly in the ſhoulders. The ſpaſm or contraction at the time is ſo ſevere as to deprive the perſon of the power of holding the conductors in contact with the end plates. When kept in contact by an aſſiſtant, a ſenſation reſembling a highly heated fluid is felt ruſhing through the wriſts and fore-arm.

A piece of ſmall ſteel wire being made a conductor to unite the end pieces, on making the contact, a bright ſpark was

obſerved, with ſmall ſcintillations, and had it been in oxygen gas, the wire would no doubt have deflagrated.

The wire being armed at the end with a ſmall piece of phoſphorus, the latter inflamed inſtantly upon contact.

A connection was made from the trough to a galvanometer on the conſtruction propoſed by Pepys *. Upon moving the regulating ſcrews, the gold leaves, at the diſtance of half an inch, began to divide: one of them ſuddenly ſtruck the zinc and inſtantly inflamed, burning with a bright flame of a white colour;—a ſound was heard as though a ſmall quantity of nitre had been projected upon ignited charcoal, and about a quarter of an inch of the gold was deſtroyed, leaving a ſmoke-coloured ſtain upon the plate of zinc. This experiment was ſeveral times repeated with the ſame ſucceſs.

A ſmaller trough, conſiſting of ſixty pieces of ſilver and zinc, of an inch and a half ſquare, being connected in the order of arrangement with the beforementioned, evidently decreaſed its power, which ſeems to prove that there will be no advantage obtained by uniting troughs of inferior powers to ſtronger ones, as is the caſe with electrical batteries; but experiments are ſtill wanting completely to determine the point.

Profeſſor Pictet, Mr. A. Aikin, and ſeveral other ſcientific gentlemen, were preſent at theſe experiments.

GERMINATION.

E. A. Lefebure, aſſiſtant chemiſt in the School of Health at Straſburgh, has lately made ſome curious experiments on germination. As he employed in his experiments only rape-ſeed, they cannot be conſidered as ſufficiently varied to admit of general concluſions; but as they may furniſh hints to others who may be diſpoſed to give them greater latitude, we ſhall briefly ſtate the moſt ſtriking reſults.

Lefebure firſt obſerves that taking away the cotyledons or ſeed-leaves, retards and weakens vegetation, but by no means impedes the germination, if the upper part of the fibre, to which the cotyledons are attached, be not removed. M. Lefebure contradicts Böhmer, who ſays that imbibing the moiſture of the earth is performed merely by the umbilical fibre; whereas Lefebure found, by experiments, that this function is diſcharged by the whole ſurface of the ſeed. The earth is merely the excipient of the matter requiſite for the germination of ſeeds. The conditions of tenderneſs, moiſture, warmth, and darkneſs of colour in the excipient, are conſidered as neceſſary to the germination of the ſeeds depoſited in it. M. Lefebure, after the example of Bonnet, made choice of other ſubſtances for excipients, and found that

* See page 38 of the preſent Volume.

the ſeeds germinated in ſeveral of them; but not in the oxide of mercury, alcohol, ammonia, camphor, and ſaltpetre: nay, oxide of mercury, cantharides, and ſalts, deſtroyed vitality and the property of germinating. Many of theſe matters, and particularly ſalts, ſeem to impede germination, chiefly by their requiring too much water for their ſolution, and by theſe means depriving the ſeeds of it: for this reaſon, cream of tartar impeded germination the leaſt, becauſe it deprived the ſeeds the leaſt of water. Aſhes alſo impeded germination as long as they contained ſoluble ſalts, but as ſoon as they were oxidated they promoted that proceſs. M. Lefebure examined alſo the different depths of the earth at which ſeeds germinate, the neceſſity of drawing the carbon from the earth, and of the acceſs of atmoſpheric air. Though many caſes are known in which ſeeds have germinated without the acceſs of air, ſhut up in animal bodies or in potatoes, the matter of light, however, was not excluded.

Of the different kinds of gas of which the atmoſphere conſiſts, germination requires oxygen alone. Carbonic acid, hydrogen, and azote, on the other hand, impeded germination without deſtroying vitality. Seeds grew in atmoſpheric air, however, mixed with different ſubſtances, provided it contained oxygen. The air in which ſeeds had germinated, M. Lefebure found to be ſurcharged with carbonic acid.

He examined alſo, in a more accurate manner, the influence of water on germination, and found that the more foreign matter water is impregnated with, the more unfit it is for the purpoſe of germination.

THE ARTS.

In order to diffuſe a knowledge and inſpire a taſte for the fine arts, the French government has reſolved to eſtabliſh galleries in 15 of the principal towns of the republic. The principal motives for this arrangement are explained in the following report, preſented to the Conſuls of the French republic, by the miniſter of the interior, 31ſt of Auguſt.

"The muſæum of arts preſents at this moment the richeſt collection of paintings and antique ſtatues in Europe; there are to be found all the riches which were diſperſed before the revolution. We may reckon at preſent 1390 pictures of the foreign ſchools, 270 of the antient French ſchool, and more than 1000 of the modern ſchool. It poſſeſſes 20,000 deſigns of different ſchools, 4000 copper-plate engravings, and 30,000 prints, beſides 150 antique ſtatues, and the moſt valuable articles in Etruſcan vaſes, tables of porphyry, &c.

"The immenſe gallery opened for public inſpection cannot contain a moiety of the *chefs d'œuvre* of which the nation

is poſſeſſed. More than 1000 pictures are depoſited at Verſailles, and 6 or 700 remain in the cabinets of Louvre, in expectation of a place proper to receive them.

"The collection of theſe *chefs d'œuvre* was doubtleſs an advantage at thoſe critical moments when the breath of Vandaliſm would have deſtroyed, without remorſe, the works of genius.

"It was an acquiſition we were in want of, when our victorious arms procured us the numerous riches of Italy. But theſe times are no more! and we ought now to endeavour to conciliate the great advantages derivable from the arts, with the duties we have to fulfil towards the departments; ſome of which have enriched us with their ſpoils, and all of which have concurred in appropriating to us the rich monuments of vanquiſhed nations.

"Without doubt Paris ought to reſerve the *chefs d'œuvre* of every kind. Paris ought to poſſeſs in its collection the works which moſt eſſentially belong to the hiſtory of the arts, which mark its progreſs, characterize its qualities, and enable the artiſt to read on its pictures all the revolutions and periods of painting. Paris merits on every account this honourable diſtinction: but the inhabitants of the departments have alſo a ſacred right to a ſhare in the fruit of our conqueſts, and in the inheritance of the works of French artiſts.

"This conſideration alone will doubtleſs not permit the French government to heſitate with regard to the manner in which it ought to act; but this determination, which ſprings from a ſentiment of juſtice, ſhould nevertheleſs be fortified by the idea, that it is conformable to the real intereſt of the arts.

"In fact, the contemplation of what is beautiful develops talent, and inſpires the artiſt better than leſſons. The valuable picture, which by being placed by the ſide of one ſtill more ſo is diſregarded, will recover its right to admiration when it ſhall be iſolated, or, to uſe the expreſſion, reſtored to itſelf. Some paintings, by being ſent to the place that gave them birth, will acquire a new intereſt by tradition, and the recital of the circumſtances which attach to productions of merit. The inhabitants of Anvers, Montpelier, and Andelys, will be fond to ſhow foreigners the *chefs d'œuvre* of their countrymen Rubens, Bourdon, and Pouſſin; and the traveller will be unable to direct his ſteps to any part of the republic, which will not offer a rich collection of pictures, or the work of ſome men of genius who have ſhed luſtre on their country.

"However, the monuments of painting muſt not be diſſeminated at hazard among the different points of France.

In

In order that the collections may be profitable to the arts, they ought only to be formed where a degree of knowledge already acquired may give them a value, and where a numerous population and the natural disposition of the people afford a presage of success in the education of the pupils. It is for that reason I propose to form 15 grand depôts of pictures at Lyons, Bourdeaux, Strasburgh, Brussels, Marseilles, Rouen, Nantes, Dijon, Toulouse, Geneva, Caen, Lisle, Mentz, Rennes, and Nancy.

"But it is little to have determined the places for these depôts—it is necessary to make choice of such collections as present an interesting series of paintings of all masters, of all kinds, and of all schools; and I think it is necessary to appoint a committee charged with the labour of preparing for each of the cities pointed out the collection adapted for them."

A decree passed agreeably to this report.

DISCOVERIES IN AFRICA.

According to accounts from Trieste, dated March 1801, published in the German Mercury. Horneman the traveller had written to a friend in Egypt, by the last caravan from Darfur, which had been absent for two years, because the last had been plundered during the unsettled state of affairs in Egypt. At the time Horneman wrote he was at the court of the king of Darfur, where he had met with a very favourable reception, and was treated with great kindness.

SILVER MINE.

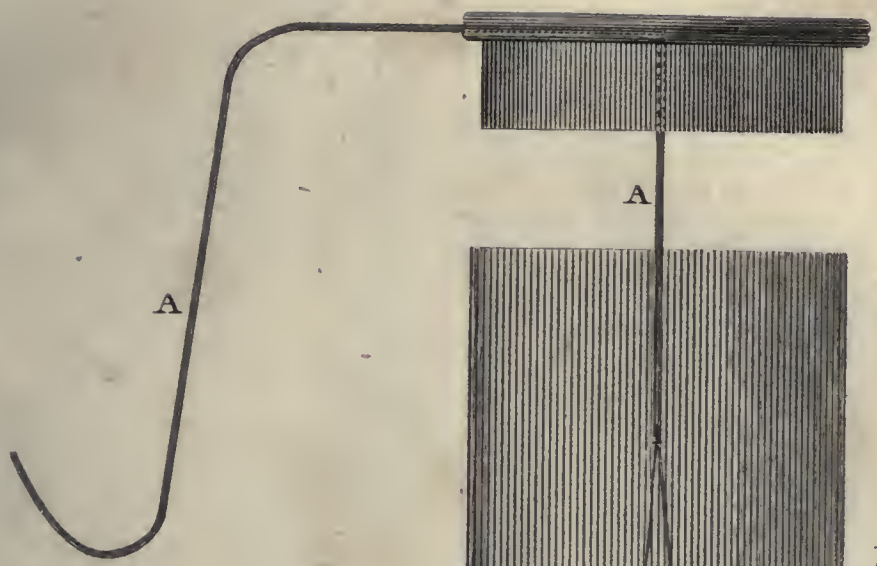
We lately announced the discovery of a lode of silver in the Herland mine. The working of it, we are sorry to hear, has been discontinued, as the produce was not equal to the expense. Several other mines in Cornwall have been abandoned for the same reason.

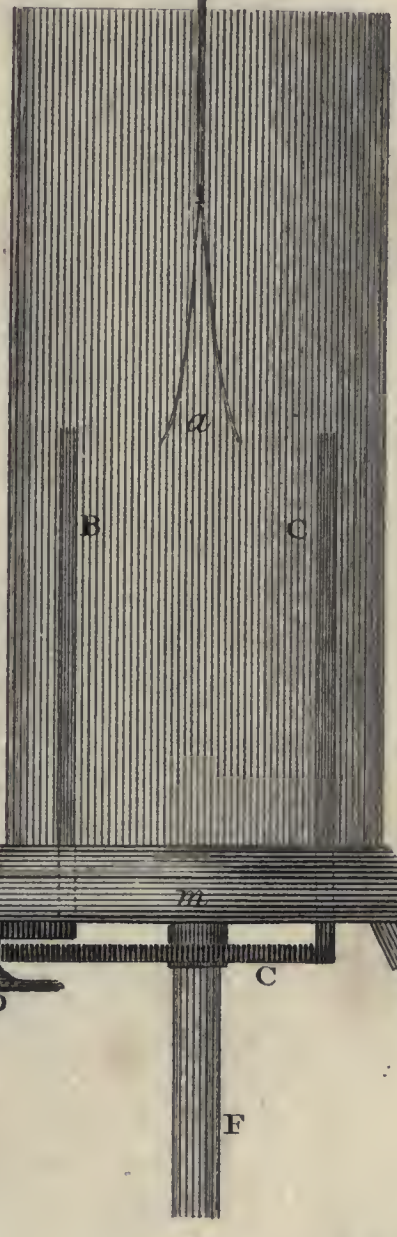
HORSE WITHOUT HAIR.

The following notice has been published by Professor Pfaff, of Kiel, respecting the horse without hair: in one of the Berlin journals, *Neue Berlinische Monatschrift* for February, 1801, G. F. Sebald, groom and farrier at Ulm in Suabia, has given a short account of the real nature of the horse without hair, which has lately been described by Lasteyrie in the *Journal de Physique**. This horse had excited the attention also of the German naturalists: he was considered in general as a variety produced by the influence of climate, and Professor Nauman inserted an engraving of him in his Manual on the Science of the Horse, and assigned to him a very warm climate as his native country.

* See Philosophical Magazine, p. 36 of this Volume.

M.





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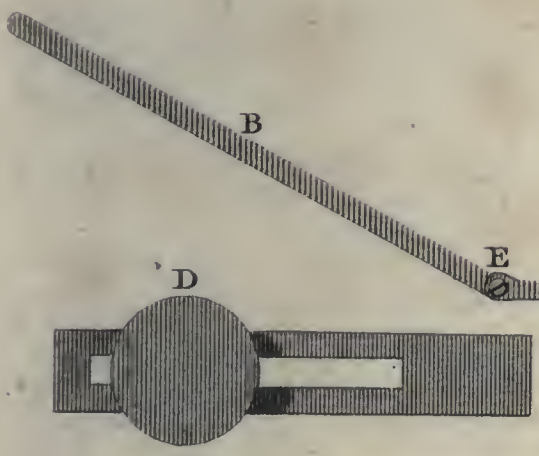

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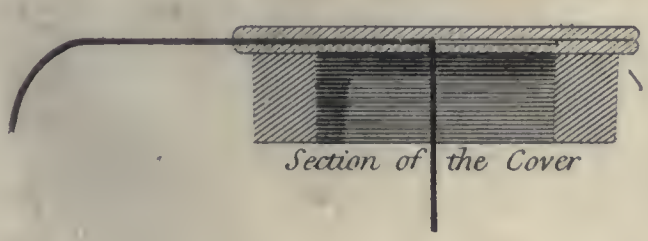

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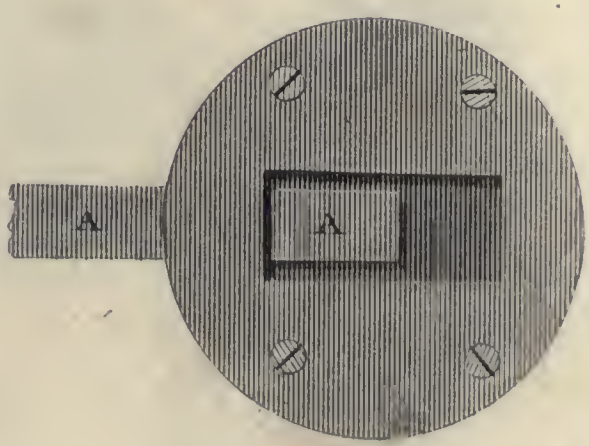

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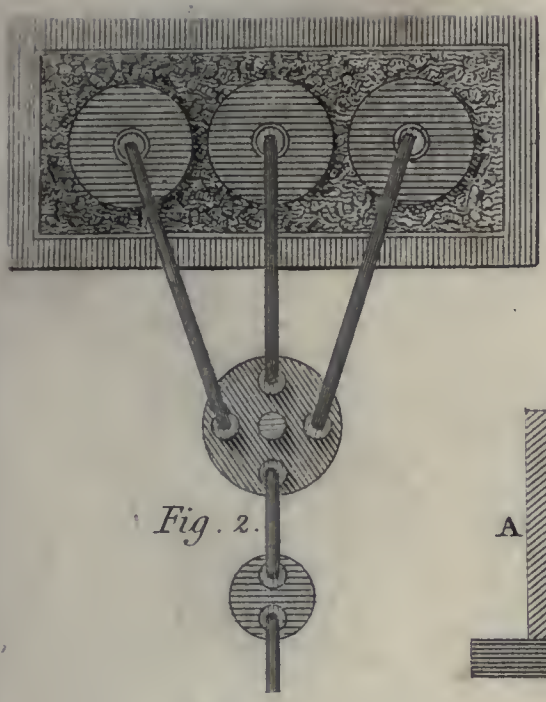
Lowry sculp.



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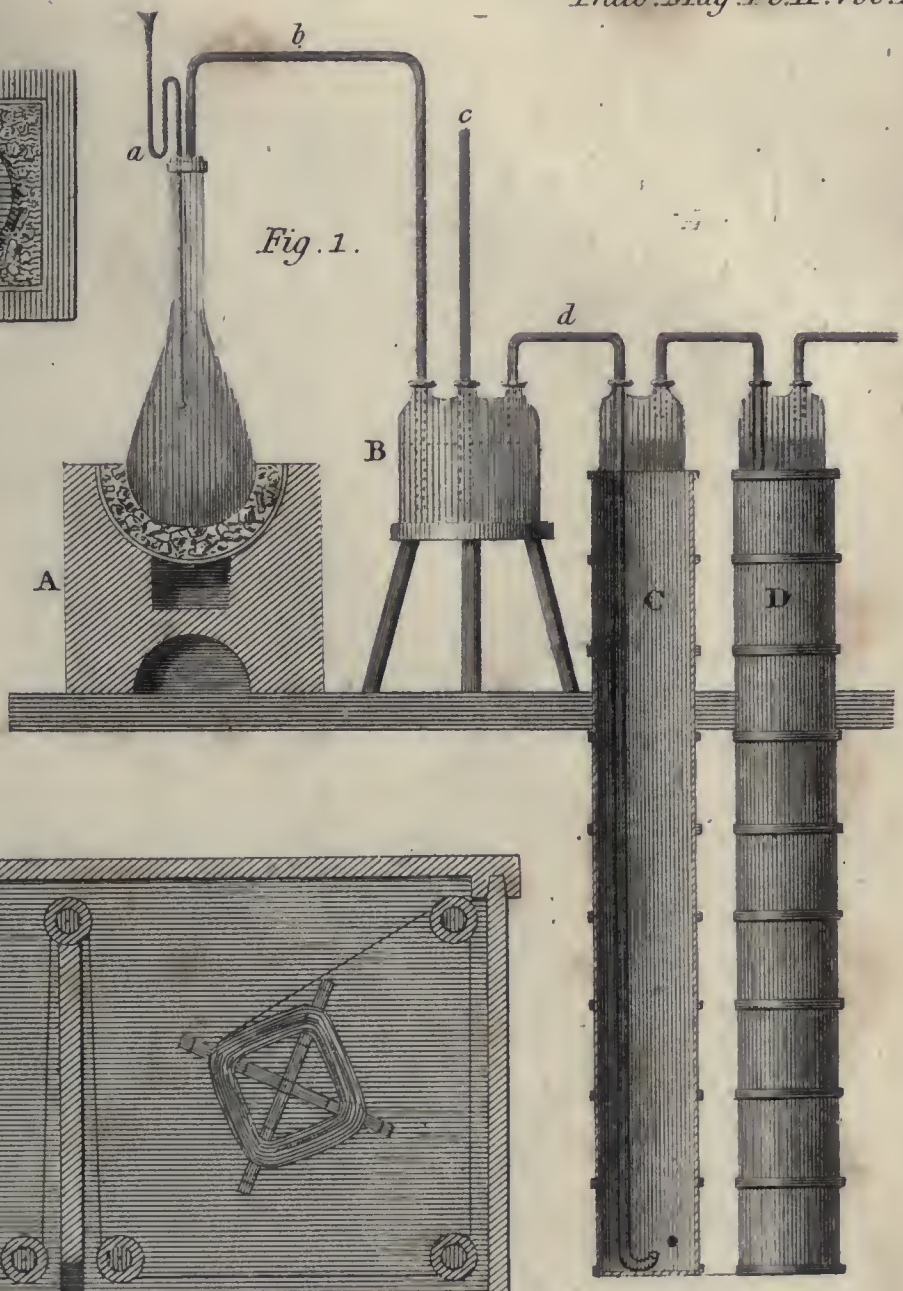

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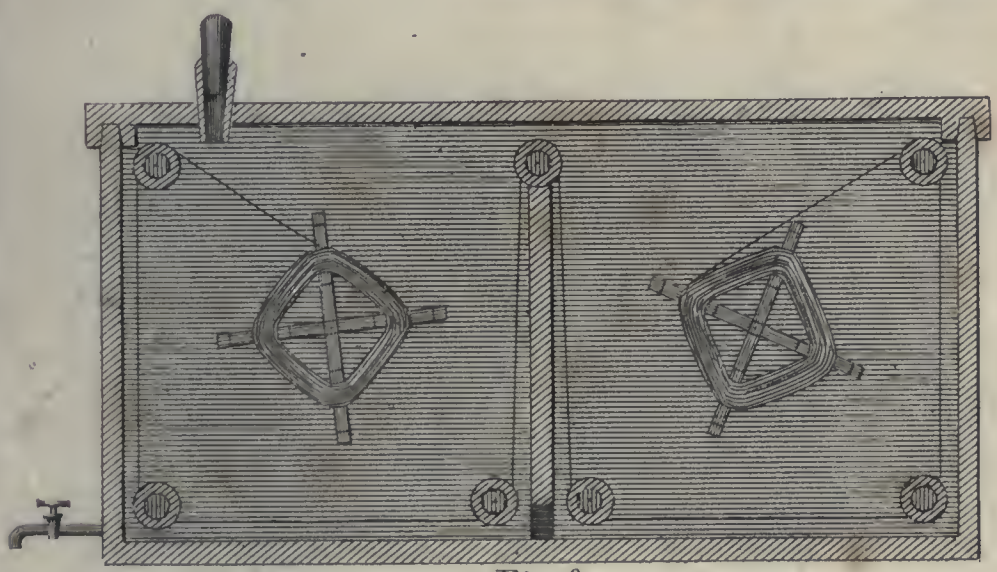

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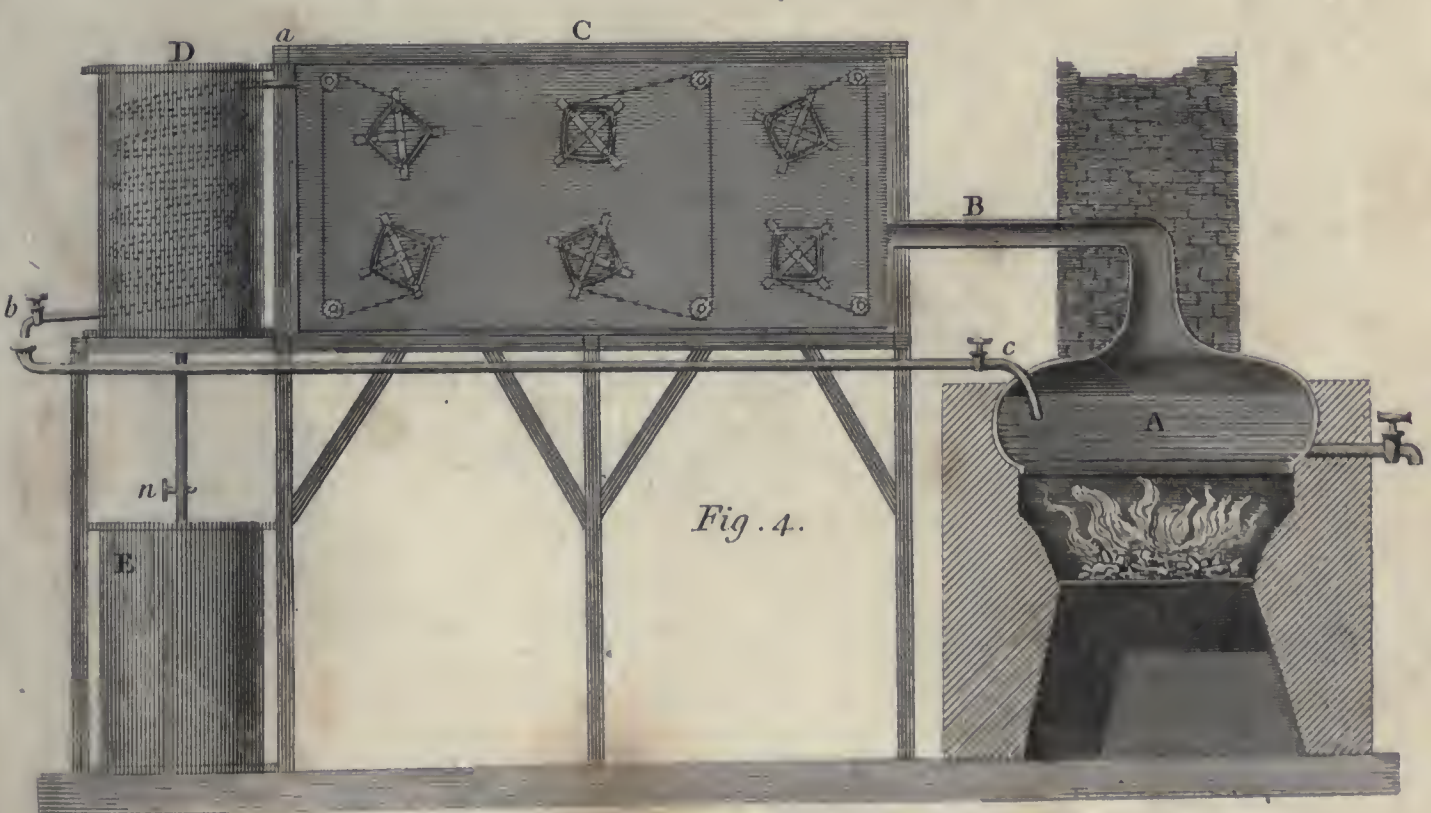

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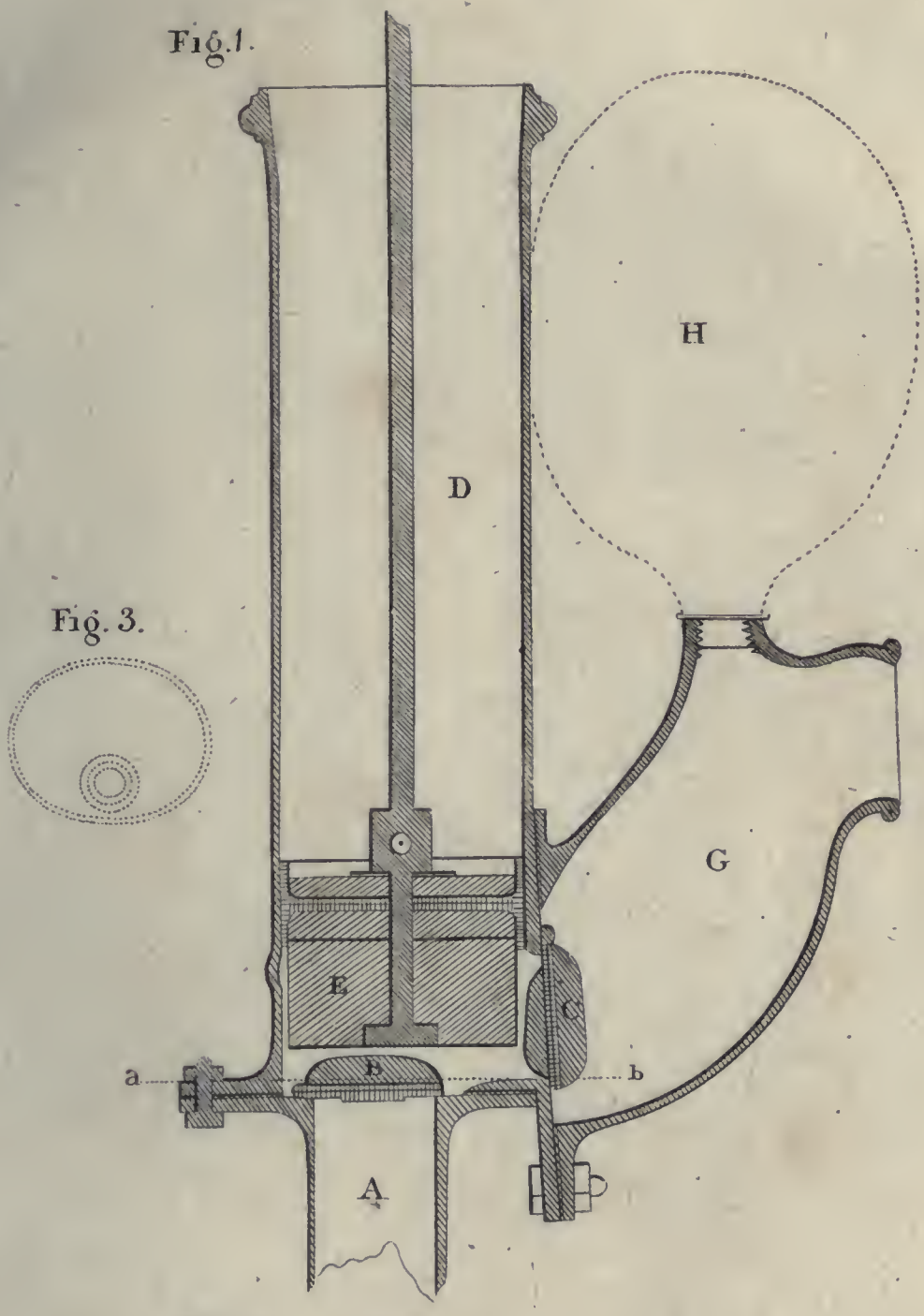

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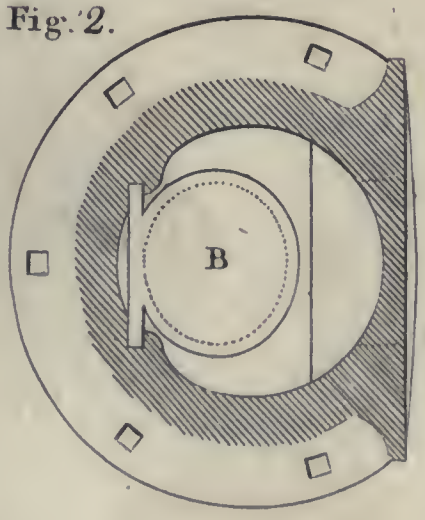

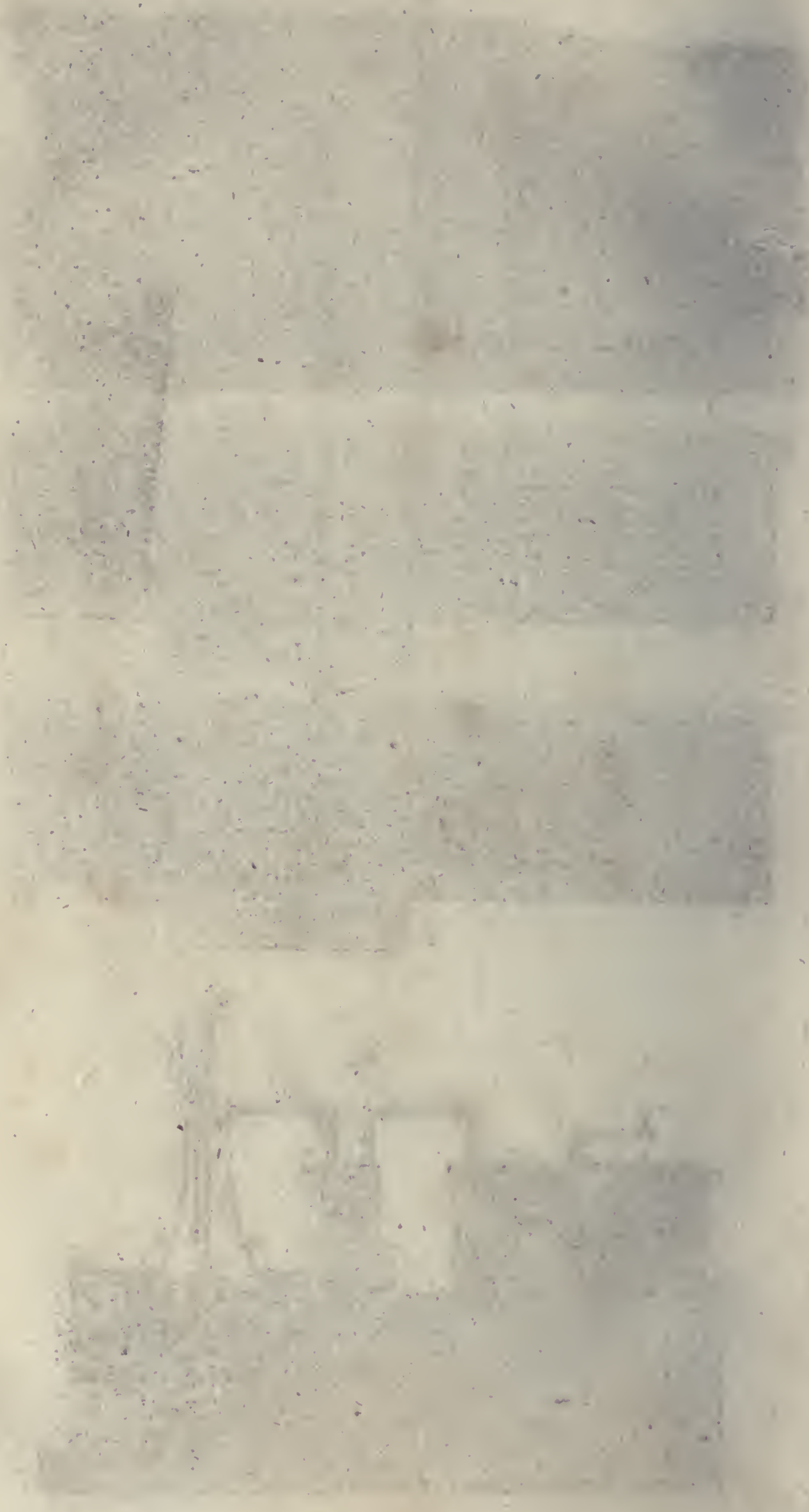

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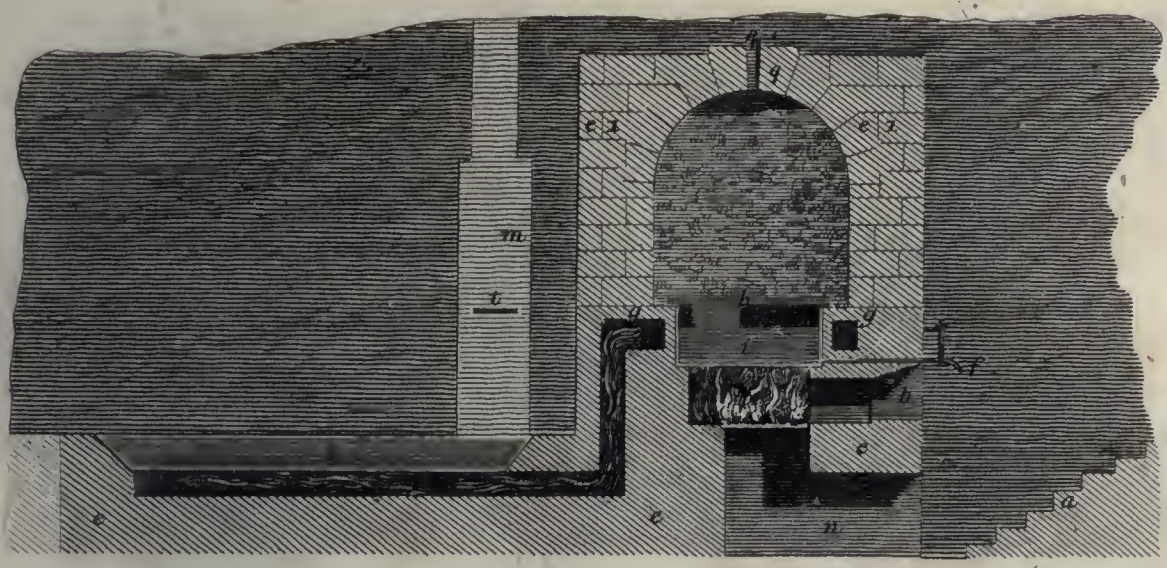

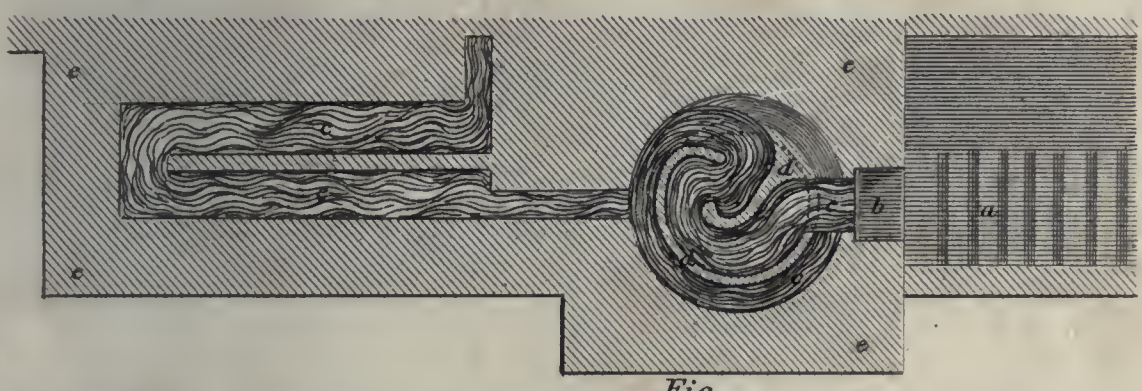

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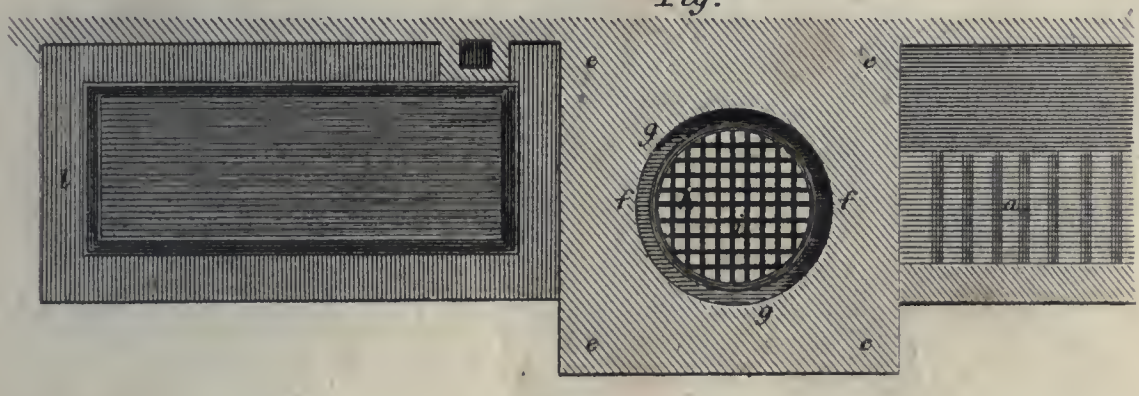

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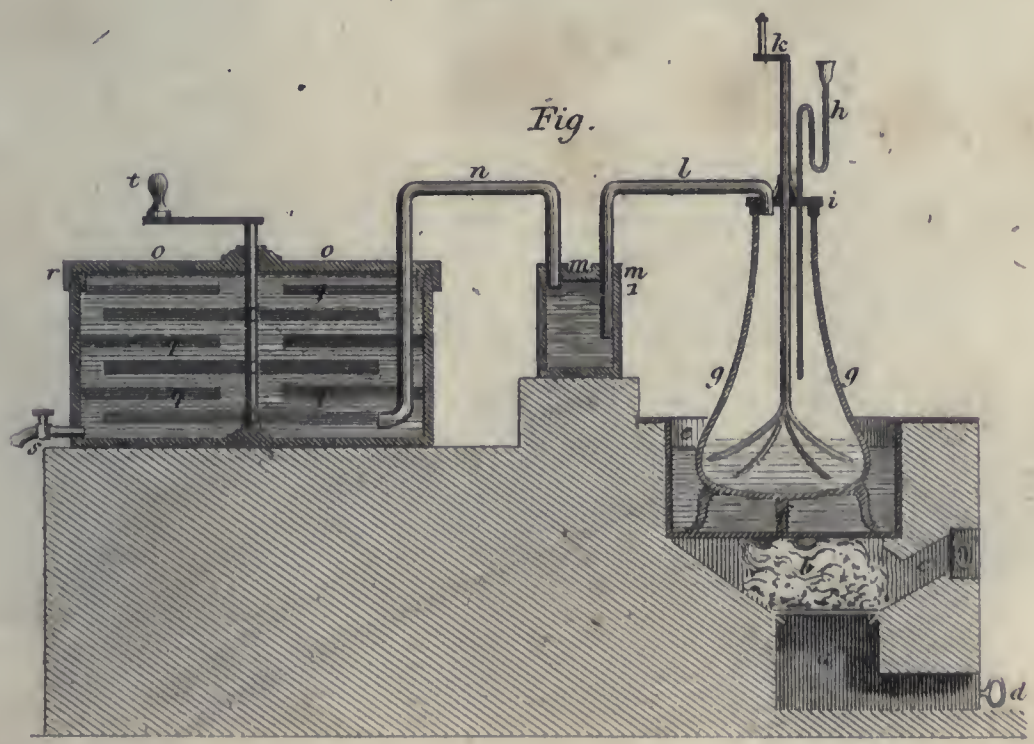

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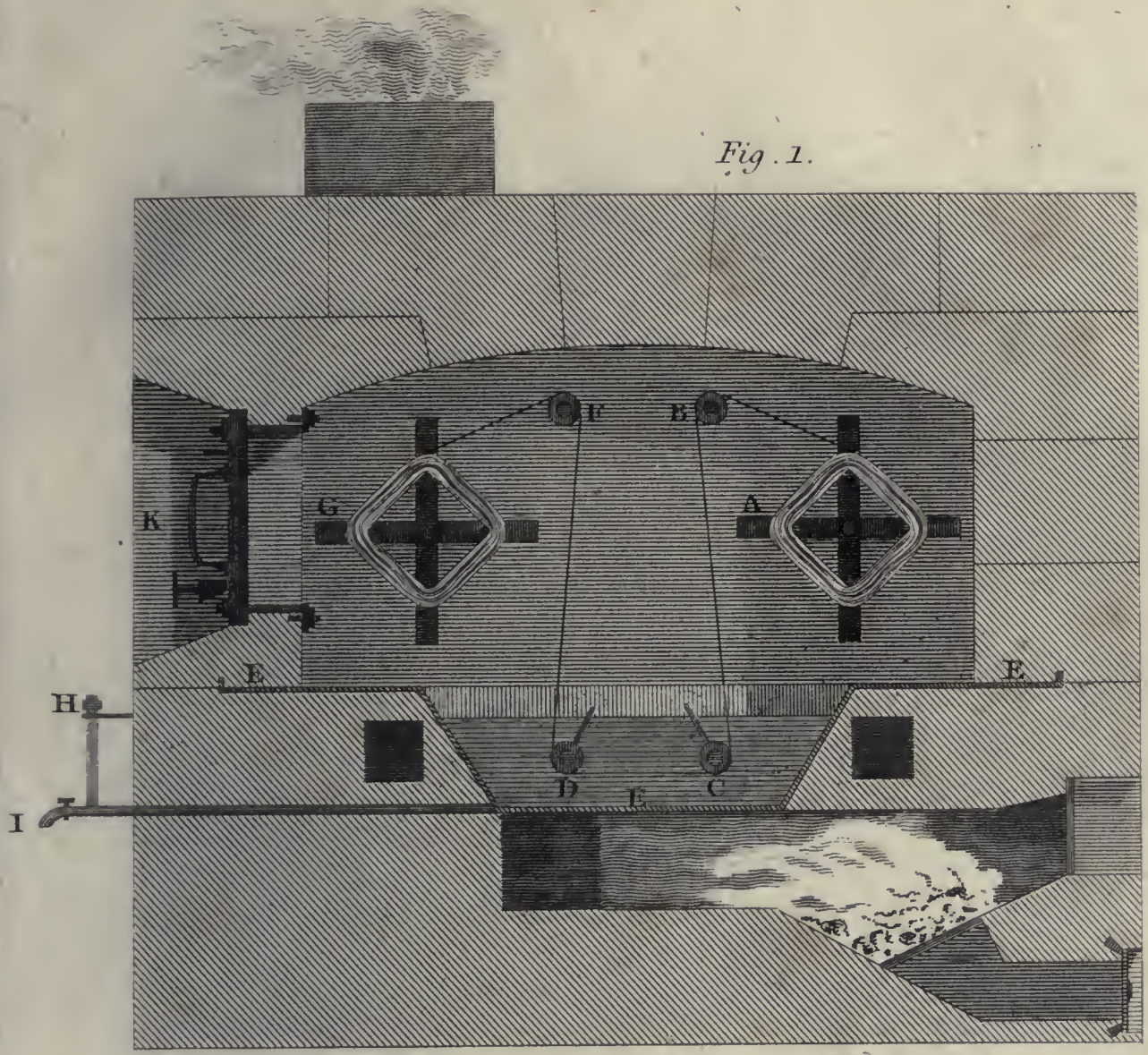

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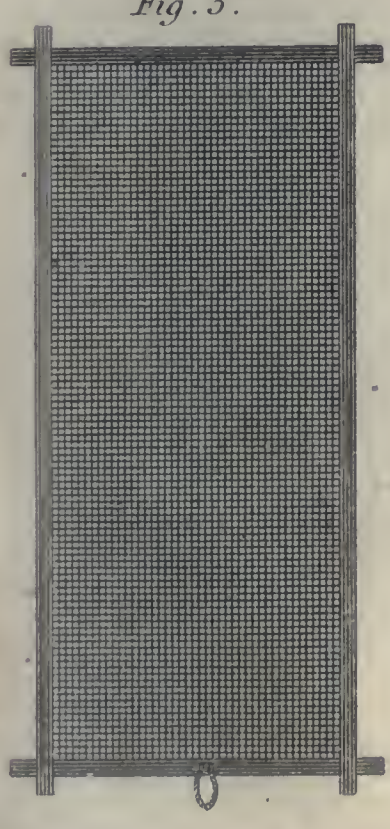

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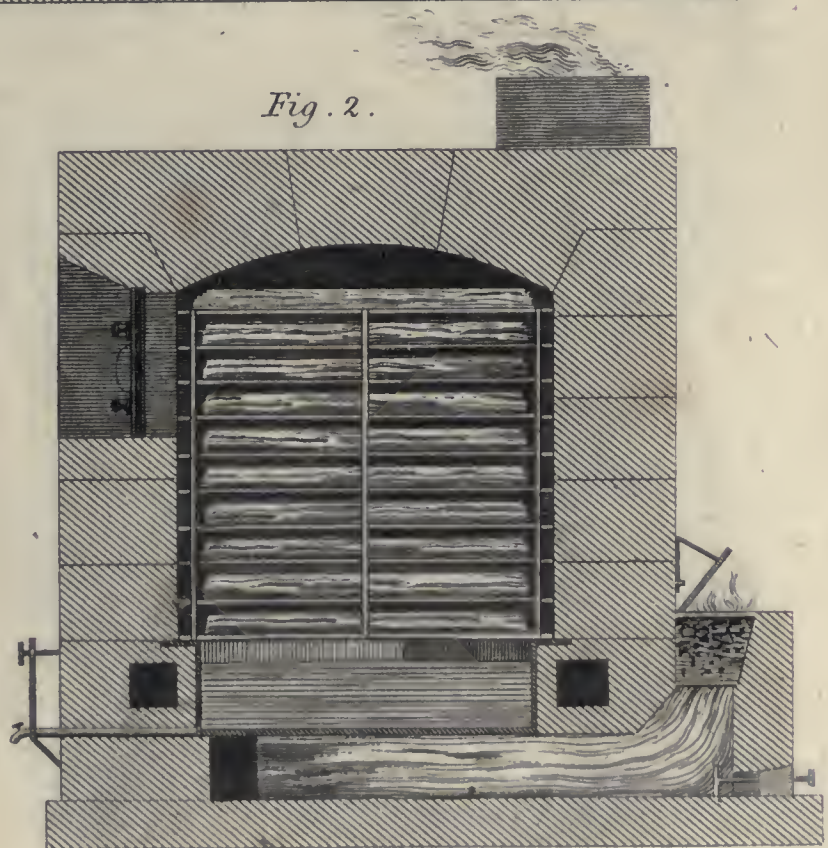

Lowry sculp.

M. Sebald in this account gives a very correct and minute hiſtory of this animal, from which it reſults, that he was originally nothing more than a common German hack, formerly covered with hair, and in the poſſeſſion of a coachman of Hohenlohe-Ochtinguen, in Franconia, who ſold him to a peaſant near Ober-Maſholderbach, where that change took place, which rendered him an object of curioſity.

According to the declaration of all the inhabitants of the village, the proprietor of this horſe, who has been dead ſome time, finding the animal attacked with the ſtrangles, gave him to eat, for a whole year, leaves of the ſavine tree, which grew in his garden, by way of a cure, and afterwards as a preſervative. Soon after uſing this nouriſhment, the horſe began to have new hair, which the peaſant conſidered as a good ſymptom, and he hoped to make the horſe a new animal. He continued therefore to ſupply him with this new food. The hair, though beautiful, ſmooth, and ſleek, dropped off, and was ſucceeded by another coat no leſs beautiful: but after ſome months the hair diſappeared entirely, in ſuch a manner that the horſe became quite naked. Nature, however, made a laſt effort; the hair grew up for the third time; but it at laſt dropped off entirely, the peaſant always continuing his treatment with the green leaves of the ſavine tree.

The horſe therefore became naked and free from hair for the fourth time, and irreparably, except a few hairs on the upper part of the neck, on the four feet and the tail, of which the perſon to whom the peaſant ſold the horſe, and who had become the jeſt of the whole village, at laſt deprived him. In this ſtate M. Sebald found the horſe of which he had before heard ſome account, at the houſe of a coachman of Ochtinguen, to whom the peaſant had ſold him for three Louis d'ors, in the month of January, 1793, he was then covered with a cloth, and employed in drawing a cart.

M. Sebald then informs us how the horſe was carried about from place to place by his new poſſeſſor, in order to exhibit him for money, pretending that he was a horſe from the iſland of Cyprus. The coachman of Ochtinguen being ſtruck with ſome qualms of conſcience, and fearing that the impoſture might be detected, reſolved to ſell him to an Italian, who afterwards ſold him to M. Alpy, in whoſe hands this horſe became ſo famous.

As M. Sebald mentions all the places, and being himſelf a perſon whoſe teſtimony is above ſuſpicion, natural hiſtory muſt in future renounce this pretended addition of a new race, but this particular effect of the leaves of the ſavine tree is an object worthy the attention and reſearches of veterinary profeſſors.

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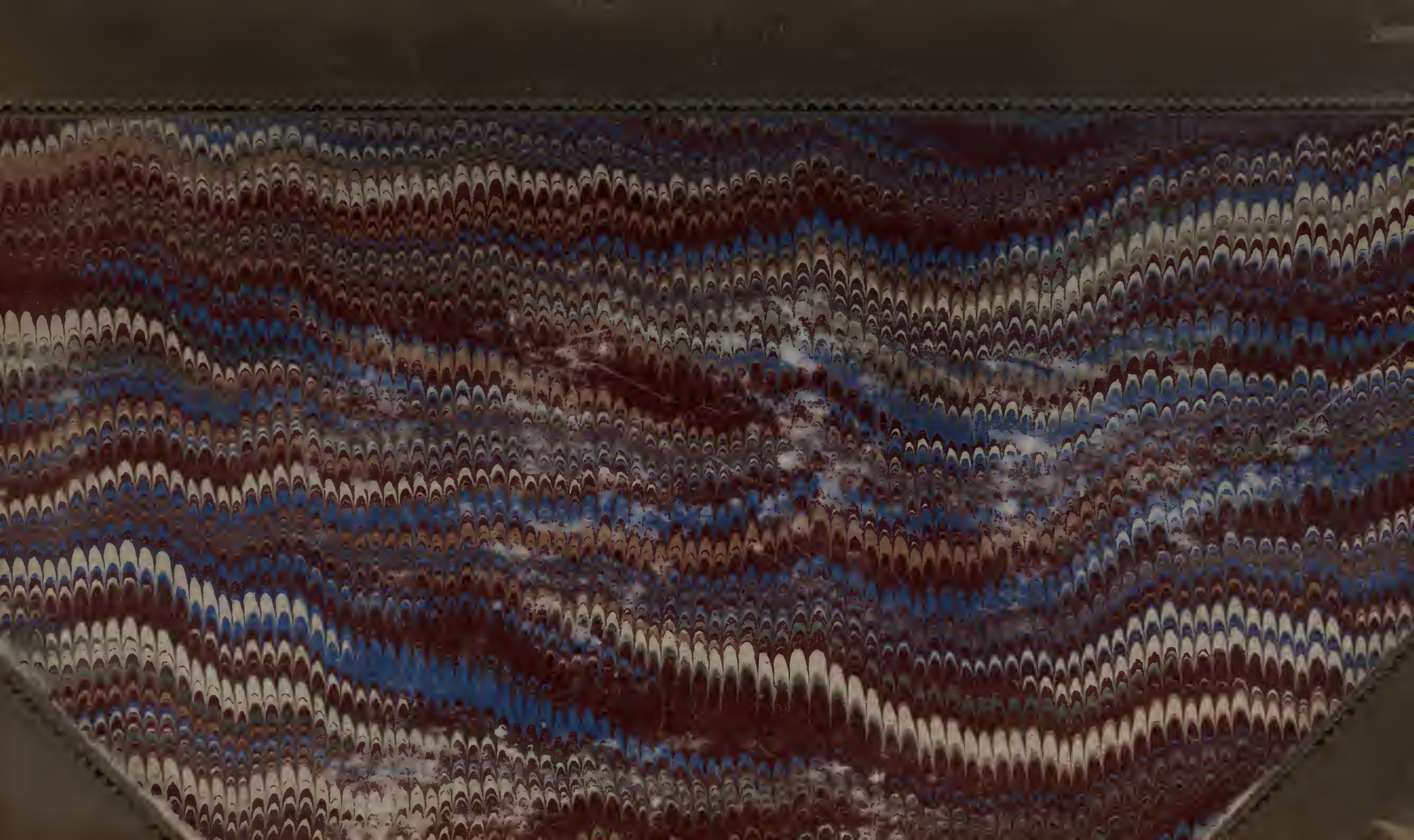
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